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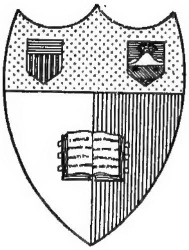

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A BIBLIOGRAPHY OF FISHES

BY
BASHFORD DEAN

EXTENDED AND EDITED BY
EUGENE WILLIS GUDGER

WITH THE COÖPERATION OF
ARTHUR WILBUR HENN

VOLUME III

INCLUDING INDICES, GENERAL BIBLIOGRAPHIES, PERIODICALS RELATING TO FISHES, EARLY WORKS, VOYAGES AND EXPEDITIONS, ADDENDA, AND ERRATA OF VOLUMES I AND II

NEW YORK
PUBLISHED BY THE MUSEUM
1923

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THE
AMERICAN
MUSEUM
OF
NATURAL
HISTORY
SCIENCE
EDUCATION

NEW YORK
PUBLISHED BY THE MUSEUM
1923

"THE BOOKES REQVEST

Reede ouer, then judge,
Condemne not before:
With iudgment iust reiect,
Or els imbrace my lore.
Mine Authour was the first
And last, as I suppose,
That euer did assay
These secrets to disclose,
If ought be wrought awry,
And seems to thee vnsounde,
With penne I pray amende,
And not with tongue confounde."

The publisher's prefix to the English version of Janus Dubravius's "A new booke of good husbandry." London, 1599.

THE UNIVERSITY PRESS, CAMBRIDGE, MASS.

THE following comments of writers, gathered in miscellaneous reading, seem fittingly to express our sentiments at different times while we were compiling the present volume. Now that our *opus* is completed, we may be forgiven for recording them:

B. D.

"Deep calleth unto deep at the noise of thy waterspouts: all thy waves and thy billows are gone over me."

42nd Psalm.

Tetzel the Bohemian, gazing at the sea at Cape Finisterre, remarked, — as if he had our bibliography in his mind's eye — "The end of it no one knoweth, save God alone!"

The Bohemian Ulysses (1477);
MRS. HENRY CUST, *Gentleman Errant*, 1907, p. 87.

"I truly believe that in the sea there is abundance of infinitely admirable things, *whereof God alone hath knowledge.*"

LAURENT VITAL in *Voyage de Charles Quint*, 1518.

"But to describe the [fishes, the] subtleties, the many strange devices and order in the same, I do lack wit in my gross old head and cunning in my bowels to declare the wonderful and curious imaginations in the same invented and devised."

CAVENDISH'S *Wolsey*, 1556
(Routledge ed. 1885, p. 106).

"A painful work it is I'll assure you, and more than difficult, wherein that toyle hath been taken, as no man thinketh so no man believeth, but he that hath made the triall."

ANTHONY À WOOD in the Preface to his *History of Oxford.*

"Such an enterprise is thankless for the one who charges himself with it; but it can be received with some favor by those naturalists whose researches are facilitated by it."

Note by HIPPOLYTE CLOQUET appended to his *Fish Bibliography*, 1821.

"No extended record of facts grows too old to be useful provided only that we have a ready and sure way of getting at the particular fact or facts we are in search of. And this leads me to speak of what I conceive to be one of the principal tasks to be performed by the present and the coming generation of scholars, not only in the medical, but in every department of knowledge. I mean the formation of indexes . . ."

OLIVER WENDELL HOLMES.

"The history of a science is the palladium of its freedom; it prevents it from being tyrannized over by narrow bigoted viewpoints."

Motto which appeared with a lithographed portrait of Ludwig Choulant in 1842.

PREFACE TO VOLUME III

The present volume concludes the Bibliography of Fishes, and in it is the test of the practical value of our task, which is its highly developed Index. For the reader who seeks information relating to fishes should be able promptly and easily to put his finger on whatever has been written on his theme, — whether it deals with fishes living or fossil, their distribution, physiology, anatomy, development, teratology, their life-habits, minute structure, commercial importance, artistic interest, food-value, or their significance in biological economy. In fact it is our hope that such a Bibliography will be useful not to ichthyologists only but to seekers of knowledge everywhere.

Thus the chemist who studies egg-yolk, the sanitary engineer who aims to destroy disease-bearing insects, the physiologist who seeks data on the regeneration of nerves, the student of the cancer problem, the anthropologist who describes the life-habits of primitive peoples, the bacteriologist whose work touches diseases in fishes, the medical practitioner who would know the earlier hosts of certain parasites or about oils digestible to his patients — even the amateur of heraldry, or the theologian — each and all of these will here find materials which concern his work.

If the reader will refer to the table of contents mapped out for the Bibliography in Volumes I and II he will note that hitherto were published only (I) Authors' Lists of Titles and (II) Anonymous Publications. There remained (III) Pre-Linnæan Works, (IV) General Bibliographies which included references to Fishes, (V) Voyages and Expeditions, (VI) List of Periodicals relating to Fish and Fish Culture, (VII) Subject Index of Authors' Titles and Final Index, and (VIII) Addenda and Errata of Volumes I and II.

Those headings, then, (IV) to (VIII), will be found in the present volume. The original plan has been changed only in detail. Thus headings (VII) and (VIII) have been transposed for convenient reference, and the Addenda (placed at the beginning of Vol. III) have been enlarged by introducing themes (*e. g.* fisheries or fishing methods) which earlier for specific reasons had been largely omitted. In fact, it was found that the work was undergoing an evolution of its own, on the one hand broadening its scope and on the other including even more minute details. In the former regard the editors were frequently puzzled to decide where to lay down an ultimate boundary, *e. g.* to determine whether certain groups of titles should be subdivided, rearranged or even rejected.

EXPLANATION OF MATERIALS IN THE PRESENT VOLUME

Of sections (III) to (VI) little need here be said. The *Pre-Linnæan Literature* (III) (from the earliest writings up to 1758) is cited in detail and only after laborious research. In gathering this material the works themselves have in many cases been scrutinized even to their revisions and versions, those in English checked largely after the studies of Lowndes. The earliest papers on Angling and Pisciculture follow in the main the work of Westwood and Satchell. And for the reader's convenience extremely rare works are noted as occurring in definite libraries.

Regarding *Errata and Corrigenda* (VII), a more detailed examination of bibliographies cited in special memoirs has yielded additional titles and has enabled us to correct defective citations. On the other hand, as is often the case in bibliography, we have found that lists of works cited in special memoirs are usually, if not always, seriously defective; even in so special a study as the list of papers of Dr. Gill, prepared by the Smithsonian, thirty-two titles were missed which we had earlier collected, while, truth to tell, it contained about twenty titles which were not on our cards. Or in the instance of so scholarly and detailed a work as Gemmill's "Teratology of Fishes" we have been able by consulting a greater range of authors to increase its number of references by no less than one-fourth. Another example is in Ackermann's (K. 1898.1) studies of hybrids among fishes where only nineteen hybrids are recorded, while the present work enumerates over fifty (including, of course, later citations). In general it will be found that our titles end with the year 1914 — which marks a convenient international stopping point as a result of the Great War. It is true that a number of later papers are cited in our pages, but these only for special reasons — as in rounding out the bibliographies of writers who since have died (*e. g.* Eastman, Steindachner), or in completing outstanding works (*e. g.* Jordan's "Genera" or Boulenger's "Fishes of Africa"). In certain instances where especially important papers had appeared they have been cited in our Subject Index.

The Alphabetical Index of Subjects (VIII) requires a long explanatory note. Indeed it is clear that the diverse materials sifted from a vast number of references, nearly fifty thousand, could not, in the nature of things, be reduced readily to a well ordered index. Nor was it an easy task to classify the themes of each paper for purpose of reference. Hence it may be well here to explain the steps or stages which the editors followed in their task. The *first stage* consisted in placing the dissected pages of Volumes I and II and other Authors' Titles on the tables of the members of the editorial staff, dividing the materials so far as possible in accordance with the special studies of the various workers, who could now note at the side of each title as printed the captions under which it should be indexed — which meant, in practice, that the same paper would usually be cited under numerous headings. The *second stage* in indexing was to prepare a separate card for each heading as noted above, not citing, however, the full title of the paper, but giving only the author's name and the date and order of his publication, by means of which the reader could at once locate the exact title in Volumes I or II. The *third stage* brought together cards of similar captions and filed them in large trays in an elaborately subdivided card catalogue of subjects. The *fourth stage* consisted in the editing of all material thus classified. In thousands of instances where there was doubt as to actual contents the original papers were examined, titles revised and errors corrected. In very many cases authors were found to have given inadequate descriptions of their work and these were corrected. Thus, who would have known from its title-page that the work of Dabry de Thiersant (1872.1) had anything to do with the fish fauna of China, or from the title of Mark's paper (1890.1) on the ganoid Lepidosteus that it was to become the standard reference for the egg-membranes of Teleosts? Unfortunately, it was not practicable to examine every paper, and for this reason there will be found numerous errors of omission in our work. For the papers of the United States Fisheries Commission we had not then at hand the admirable index prepared by Miss MacDonald, which would have saved us much time in "checking up" our cards; on the other hand, careful use was made of earlier bibliographies of which in all over fifty thousand pages were taken into account.

The *fifth stage* in the growth of the Index was the introduction of an "honor system": the reader should be told what papers were the best in his field, and the first which he should consult. To this end the asterisk, familiar to all in Bædecker's guide-book, was brought into play, although never carried to the degree of introducing double "stars" at the head of each name and title. Such a mark, then, denotes an excellent paper, generally accessible, and with references up to date. Inaugural dissertations do not come into account here, for they are often printed privately and are rare. In case the paper is a classical one, like Agassiz's "Poissons Fossiles," or Johannes Müller's "Myxinoiden," or is the most important one upon a subject, it is printed in black face type. It is obvious, of course, that our estimate of the value of a particular paper may not be just, but the general reader will probably be willing to take chances, and in case he finds us in error we must console ourselves with Newton's complacent dictum that "it is impossible to print a book without faults."

The *sixth stage* in preparing the Index was decided upon only after numerous conferences: should the arrangement form a dry-as-dust conventional index or should it be classified, with references so grouped as to give the reader at one time and in one place materials for selection. Of many headings, too, summaries and introductions were recommended. This general procedure, it was agreed, would give an encyclopedic value to our work, but it would also entail vast labor upon our staff. It meant that the references of the bibliography in their vast number be again sifted over, and many of them boiled down for citation. Such a task the editors next attacked and they have now brought it to a successful conclusion — cheered not a little by the favorable comments of critical bibliographers — such a national expert, for example, as Dr. Lydenberg of the New York Public Library noting that a work on such lines "would have no parallel in the history of science," — which is praise indeed! Certainly of no other branch of the Animal Kingdom is there known to us as complete a compendium of the literature or one so minutely digested for the reader.

It became clear also that the *sixth stage* in the work, which assured to it an Annotated Index, would have to be followed by a *seventh*, which was to compile in the end *an index of our index* (VIII). This, it was agreed, would prove more or less of a secretarial undertaking. It meant, nevertheless, that the editors should indicate in the Annotated Subject Index all words or themes which should be placed in alphabetical order in the Final Index. Thus in the Subject Index, such a theme as "Egg" should be considered in general and in detail, *in rebus* membranes, yolk, nucleus, etc., and under each caption would naturally appear many technicalia — but arranged in their natural, not in their alphabetical order, *e. g.* permeability, micropyle, etc. But even thus arranged these names would not be so scattered that the reader would have trouble to find them; for he could pick them up at definite pages in an *alphabetical list at the end of the volume.*

There were certain guiding principles which were laid down during the progress of the work:

(a) Regarding *species, genera and many families* of living and fossil fishes we could not attempt to cite purely systematic references in greatest detail. There have been described probably twenty thousand kinds of fishes and to each of these are many references, in certain cases hundreds and even thousands. To attempt, therefore, to include them in the present work was hardly practicable; for one thing, it would entail years of added labor and extra volumes. Moreover, such a labor seemed to the editors the less necessary since it is the particular branch of the subject which has already been given the greatest attention. Hence the student of the systematique is here referred only to general works. *In a word, the present volume leads the investigator through the literature of the fishes only so far as families and genera: it records species rarely.*

Only in instances of rare and unusual fishes have we cited the literature *in extenso, e. g.* deep-sea fishes of especial interest in morphology or physiology, or fishes of restricted localities. For new species the reader must still consult his Zoölogical Record. For genera he has now the splendid work of Jordan (1917.1). None the less, he will here find references to extensive papers which cite new species in considerable number, together with many useful taxonomic revisions and synopses. His further systematic details he must continue to "run down" in Jordan and Evermann's "Fishes of North and Middle America," Boulenger's "Fishes of Africa," Day's "Fishes of India," etc., Gunther's "Catalogue [1859–70] of the British Museum," for living fishes, and Smith Woodward's for fossil [1889–1901], the latter forming the "Bible" of all students of this theme. In the last regard it will be found that the detailed indexing of fossil teeth has been largely omitted, though fossil spines, ichthyodorulites, have been included. In a word, the compilers have tried, so far as possible, not to reprint needlessly the classical work of systematists, or to re-index such publications as the Zoölogical Record or the cards of the Concilium Bibliographicum.

(b) In matters of *Synonymy* we have not attempted to decide questions of priority in nomenclature: we have accepted a name as an author has given it, save in case its synonymy was obvious. In general we have been content to follow technical names which are well known.

In the case of *Group-names, e. g.* Ganoidei, we have sometimes for convenience followed older and popularly accepted terms and for the same reason we have adopted the groups for classification given in Cambridge Natural History (1904). These at least are clear and accessible; and although we do not personally subscribe to them *toto cœlo,* we feel that our present function is rather to place in the reader's hand sources of information than to decide for him which kind of classification he should ultimately adopt.

Regarding acknowledgments: — The early history of the present undertaking has already been recorded (Vol. I, viii-ix). In 1917 the United States entered the war. In this year, fortunately, Volume II was published before the editors were able to find their way into the service of the Government. Dr. C. R. Eastman was presently ordered to Washington and elsewhere, Mr. Arthur Henn enlisted for France and the writer "joined up" with the ordnance department. Then in September, 1918, occurred the lamentable death of Dr. Eastman (*cf.* Science, Feb. 7, 1919, pp. 139–141), which the writer believes was a direct result of his activities in the war. It was upon him, as we have noted, that the responsibility of editorship had fallen in earlier years (from 1914 to 1917), and it was under his care that Volumes I and II were published.

In 1919, Dr. Eugene Willis Gudger, long time Professor of Biology in the North Carolina College for Women, and our constant correspondent and adviser, consented to become the editor of the Bibliography, much to the satisfaction of his friends in the American Museum. His contributions to the Bibliography include the extensive Addenda; expanding and completing the Pre-Linnæan literature; adding the smaller sections of Bibliographies, Voyages and Travels, Fisheries Journals, and Errata and Corrigenda; certain parts of Morphological Section, and most of the groups in the Systematic Section. And it was by a second stroke of good fortune that we were able again to enlist the help of Mr. Arthur W. Henn on his return from active service: such an arrangement could not have been made without the generous coöperation of Director Holland of the Carnegie Museum of Pittsburgh, in whose faculty Mr. Henn had become curator of fishes. Mr. Henn, we should note, prepared the reference cards and developed the Subject Index; he also is responsible for most of the subjects given in the Morphological Section, and especially for all the encylopedic articles; and for the most complicated groups of the Systematic Section, *i. e.*, Anguilla, Pleuronectidæ, and Salmonidæ. In addition, the staff of the Bibliography included Miss Francesca La Monte, who stuck to her task with the greatest devotion and who prepared the Finding Index.

We should note also that helpful comments were received from a number of our ichthyological friends who were so kind as to read sections of page-proof, notably Professor E. S. Goodrich of Oxford, whose comments on dermal skeleton, fins and integument are below included; also Professor J. Graham Kerr of Glasgow, whose advice was sought in the technicalia of dentition, growth and age, urinogenital system, and vertebral column.

Especial acknowledgment should be made to the President of the American Museum, Professor Henry Fairfield Osborn, who, firm in the faith of the ultimate value of our labors, stood our sponsor in obtaining the funds necessary to ensure the stipends of the editorial staff and to cover the large outlay for publication. Also to the Director of the Museum, Dr. Frederick A. Lucas, to its Librarian, Dr. R. W. Tower, and to our colleagues Mr. John Treadwell Nichols, and Professor W. K. Gregory, we are indebted for constant counsel and for help in many directions. Nor should we fail to mention the favors shown us by authorities of numerous libraries and universities, notably Dr. H. M. Lydenberg of the New York Public Library.

The author finally and gratefully records the constant inspiration received from his editorial colleagues with whom since 1919 he had weekly conferences. Entangled in other studies, he could only give the necessary time to mark his share of the copy for the Subject Index, to revise proof, and to review and decide discussions which concerned the conduct of the work.

The present volume terminates a task, infinitely painstaking, thankless, insistent, withal necessary, which has been upon our table for over thirty years. It seemed never to end, and we grew old with it; *Quousque tandem!* Our hope is only that the references we now provide will be of constant service to workers everywhere, for when all is said and done, an elaborate bibliography is the strongest scaffolding upon which any research can be built.

BASHFORD DEAN.

American Museum of Natural History.
January 15, 1923.

LOCATION OF RARE BOOKS

A list of American libraries in which may be found certain of the rare books listed in the Pre-Linnæan section, together with the abbreviations herein used.

A. G. S. — American Geographical Society, New York City.
A. M. N. H. — American Museum of Natural History, New York City.
A. P. S. — American Philosophical Society, Philadelphia, Pa.
A. T. M. — American Typographic Library and Museum, Jersey City, N. J.
Arn. — Arnold Arboretum, Cambridge, Mass.
B. A. — Boston Athenæum, Boston, Mass.
C. P. — College of Physicians, Philadelphia, Pa.
Col. — Columbia University, New York City.
Cor. — Cornell University, Ithaca, N. Y.
H. — Harvard University, Cambridge, Mass.
H. E. H. — Library of Henry E. Huntington, San Gabriel, California.
H. W. — Library of Henry Walters, Baltimore, Md.
J. C. — John Crerar Library, Chicago, Ill.
J. C. B. — John Carter Brown Library, Providence, R. I.
J. H. U. — Johns Hopkins University, Baltimore, Md.
J. P. M. — Library of J. P. Morgan, New York City.
L. C. — Library of Congress, Washington, D. C.
N. Y. A. M. — New York Academy of Medicine, New York City.
N. Y. P. — New York Public Library, New York City.
N. W. — Northwestern University, Evanston, Ill.
P. A. S. — Philadelphia Academy of Science, Philadelphia, Pa.
P. I. — Peabody Institute, Baltimore, Md.
P. — Princeton University, Princeton, N. J.
Stan. — Stanford University, California.
Surg. — Surgeon General's Library, Washington, D. C.
U. C. — University of Chicago, Chicago, Ill.
U. Pa. — University of Pennsylvania, Philadelphia, Pa.
U. R. — University of Rochester, Rochester, N. Y.
U. S. C. — University of South Carolina, Columbia, S. C.
U. T. C. — Union Theological Seminary, New York City.
Y. — Yale University, New Haven, Conn.

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EXPLANATORY NOTE

I. For economy in publication, titles have been simplified; words and punctuation marks have been omitted where they appeared unnecessary for a clear understanding of references.

II. Rules of the American Library Association have been followed as to (1) alphabetizing, and (2) transliteration of Slavonic names, with vowels as in Italian and consonants as in English. In addition, initial capitals in foreign languages are unaccented, as for instance Abo for Åbo, Etat for État, etc., and Danish and Norwegian nouns are not capitalized.

III. Additions to titles or inserted explanatory phrases are included in inferior brackets ⌊ ⌋, parentheses being retained where they occur in titles.

IV. The number of the volume is printed in bold-faced type, immediately succeeding the numerals denoting year of publication.

V. Authors' titles are arranged chronologically as to years and alphabetically as to publications within the same year.

VI. Where titles have been taken from standard works of reference (*e. g.*, British Museum Library Catalogue and the bibliographies of Agassiz, Bosgoed, Carus, and Englemann, etc.) the numbers for pages and volume have not as a rule been verified.

BIBLIOGRAPHY OF FISHES

II

A. LIST OF ANONYMOUS TITLES

Continued[1]

Anonymous. Abbildung und Beschreibung der Fische. Nürnberg, 1787. pls. 8°. Anon. 651

—— Account of a very extraordinary fish, called the Sea-Devil (*Rana piscatrix*) in a letter from a gentleman at Genoa on his travels, to his friend in England. N. London Magaz., Suppl. to vol. 1, 1785. Anon. 652

—— Allgemeine Betrachtung über die Fische. Neuesten Mannigf., 1781, **4**, 513. Anon. 653

—— Biological notes. Bull. U. S. Fish Comm. 1899 (1900), 305–310. Anon. 654

Short notes on fishes at Woods Hole.

—— The black bass (From "American Field") 19. Ann. Rept. Comm. Inland Fisheries Massachusetts 1884 (1885), 56–60. Anon. 655

—— The book of fishes. Class Pisces. London, 1851. illust. 24°. Anon. 656

For earlier ed., *See* Anon. 110.

—— Canetons [Ducklings] mangés par une truite. La Pisciculture Pratique, 1899, **5**, no. 11, 200. Anon. 657

—— [Sale] Catalogue of the library of . . . John Gerard Hecksher. 3 parts. New York, 1909. 146, 146, 89 p. Anon. 658

2442 items listed in ichthyology, angling and fisheries.

—— Ceylon: a general description of the island, historical, physical, statistical: containing the most recent information. By an officer, late of the Ceylon Rifles. 2 vols. London, 1876. Anon. 659

Fishes, vol. II, 242–268.

—— Christfische [alte Sitte in Nürnberg] Deutsch. Fischerei-Zeitg., 1912, **35**, 695. Anon. 660

—— The complete fisherman; or, universal angler. Containing full directions for taking all kinds of river fish; . . . likewise a compendious account of the principal sea-fish. 2nd ed. London, 1778. Anon. 661

This passed through at least 4 eds., all undated; the fly leaf of the second ed., however, is inscribed 1778.

—— Cours d'histoire naturelle ou tableau de la nature considéré dans l'homme, les quadrupèdes, les oiseaux, les poissons, les insectes &c. 7 vols. Paris, 1770. pls. 12°. Anon. 662

Abstracts in Journ. Encycl., 1770, **7**, 456. — Gött. Gel. Anz., 1771. Another ed., 7 vols., Paris, 1795.

—— Daten zur Urfischerei Siebenbürgens. II Theil. Urfischerei in den Seen der Mezözěg. Anz. Ethnog. Abth. Ungarisch. Nat. Mus., 1902, Beibl. 1, 1. Jahrg., 40–52. Anon. 663

Illustrated with 20 figures of fishing apparatus.

—— De gymnoto stuporifero Surinamensi; vim suam amittere ad magnetis accessum. Berlin. Samml. 1770, **2**. Anon. 664

—— Description d'un huso monstrueux. Acta Acad. Petropolit., 1777, pt. 1, 80. Anon. 665

—— Descriptive catalogue of the Japanese fishing industry, prepared for the World's Fair, St. Louis, by the Imperial Fisheries Bureau, Department of Agriculture. Tokyo, 1904. 33 p. 8°. Anon. 666

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[1] Initial articles ("a," "an," "the," etc.) in English and in foreign languages are disregarded in alphabetizing, and the titles are numbered serially for the purpose of reference in the Subject Index.

For previous list of Anonymous Titles, numbers 1–650, *see* volume II, p. 677–702. For Anonymou Titles before 1758, numbers 713–786, *see* in Pre-Linnæan Section this volume, p. 334.

—— Extraordinary growth of a pike. Mag. Nat. Hist., 1830, **3**, 147. Anon. 667

—— Feeding cattle on fish. Barnstable Journal [Cape Cod, Mass., U. S. A.] 1833, (February 7). Anon. 668

—— Die Fischerei der Eingeborenen in Kamerun. Fischerbote, 1913, 5. Jahrg., 152–. Anon. 669

—— Fischerei und Fischzucht in Russland. Schweiz. Fischerei-Zeitg., 1912, **20**, 174–. Anon. 670

—— Fischereiverhältnisse in Beludschistan. Deutsch. Fischerei-Zeitg., 1912, **35**, 543. Anon. 671

—— Fischereiverhältnisse in Bosnien und der Herzegowina. Oesterr. Fischerei-Zeitg., 1912, **9**, 388–406. Anon. 672

—— Fische und Fischfang in Britisch-Guyana. Deutsch. Fischerei-Zeitg., 1913, **36**, 267, 268, 289–291, 304–306; 318–319. Anon. 673

—— Fischgeräte der Steinzeitleute. Schweiz. Fischerei-Zeitg., 1912, **20**, 305–. Anon. 674

—— The fish supply of London. London Quart. Rev. 1882, no. 308, 231–242. — Rept. U. S. Fish Comm. 1881 (1884), **9**, 643–661. Anon. 675

See also Walpole, S. Add. 1882.1

—— The flight of flying fishes. Lt.-Col. Durnford's arguments. Knowl. & Sci. News, 1906, n. s. **3**, (**29**), 603–604. Anon. 676

See Durnford, 1906.1 & 1906.2.

—— Forskjelligt om fortplanting og ynglepije has koldblodige hvirveldyr. (. . . Sydamerikanske padder og ferskrandsfiske. . . .) Tidsskrift Populaera Fremstill. Naturvidensk., Femte Række, **1**, 1874. Anon. 677

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In the copy in the Amer. Mus. Nat. Hist., the 30-page introduction is politico-historical in nature and contains no reference to fishes. Next there are two pages of text descriptive of the 48 plates. These were designed in China, and finely engraved in Paris by one who signs himself "Martinet Fils." The plates in this copy have been colored by hand in magnificent fashion. The names are in both Chinese and French.

Credited by the catalogue of the British Museum (Natural History) to E. L. B. de Sauvigny and so entered in this Bibliography (vol. II, p. 394). However, according to both Engelmann and Sherborn, the editor and describer was Marie Jules César Lelorgne de Savigny [Sauvigny]. Further, according to the Catalogue of the British Museum (Natural History), these plates were reproduced in Kaiserlich-Franzische Akademische Handlung, Augsburg, 1786, along with certain ones from Willughby's De Historia Piscium, and others from Bloch's Naturalem Historiam Piscium.

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—— Zur Faunistik der parasitischen Würmer von Süsswasserfischen. Centralb. Bakter. Parasitenk., 1896, **19**, 772–784; 815–825. Add. 1896.1

—— *Myxobolus bicaudatus* n. sp., ein Parasit der Coregoniden des Vierwaldstätter Sees. Mitth. Naturf. Ges. Luzern, 1898, 2. Hft., 205–217. pl. Add. 1898.1

—— Die Myxosporidien in der Muskulatur der Gattung Coregonus. Zool. Anz., 1898, **21**, 213–214. Add. 1898.2

Zschokke, *F.*, & **Reitz,** *A.* Entoparasiten aus Salmoniden von Kamtschatka. Rev. Suisse Zool., 1914, **22**, 195–256. pl. Add. 1914.1

Zuchold, *E. v.*, **Guthe,** *H.*, & **Metzger,** *A.* (*editors*). Bibliotheca historico-naturalis, physicochemica et mathematica. Göttingen, 1866–1881. Add. 1866.1

III

TITLES OF PRE-LINNÆAN PUBLICATIONS[1]

A

Abbeville, *Claude d'* [–1632] Histoire de la mission des Pères Capucins en l'isle de Maragnan. Paris, 1612. Pre-Linn. 1612.1

Various fishes described, which are referred to by De Laet in his "Novus Orbis," 1633, p. 616, and in the French edition of the same, 1640, p. 554.

In the 2nd ed., Paris, 1614, on p. 245, is found the earliest description of the spotted eagle ray, *Aëtobatus narinari*.

Abbondio, *Giovanni*. Delle construccione della peschiere chiuse e de vivia; con un trattato della pesca di Giulio Navarino, ad uso della genti di Campagna. Palermo, 1715. 4°. Pre-Linn. 1715.1

Acosta, *José d'* [1539–1600] For life and explorations of this early Spanish traveller, *see* Miall, L. C., 1912.1. (pp. 64–71); J. R. Carricido, "El Padre José de Acosta," etc. Madrid, 1899; C. Sommervogel, "Bibliothèque de la Compagnie de Jésus," pt. 1, vol. I, cols. 31–42, Brussels & Paris, 1890; and E. Grimston as cited below.

—— De natura Novi Orbis libri duo, et de promulgatione evangelii, apud barbaros, sive de procuranda Indorum salute libri sex. Autore Josepho Acosta presbytero societatis Jsu. Salamanticæ [Salamanca], 1589. 640 p. 8 pl. 8°. Pre-Linn. 1598.1

This is the *editio princeps*. The book appeared in many editions and translations too numerous to list. Records are at hand of 4 eds. at Seville, 1589–91; 2 at Madrid, 1608–10; 3 at Salamanca, 1589–1595; Barcelona, 1591–94; Paris, 4, 1597–1616; Venice, 1596; Amsterdam, 1624; Cologne, 1598; Ursel, 1605, and Francofurt, 1617.

Early editions in other languages are:

—— Historia natural y moral de las Indias, en que se tratan las cosas notables del cielo, y elementos, metales, plantas y animales, etc. Sevilla, 1590. 535 p. 4°. Pre-Linn. 1590.1

De diversos pescados y modos de pescar de las Indias, lib. III, cap. 17 [*i. e.* 15] p. 158–162. Flying fishes are also described.

—— Historia naturale e morale delle Indie, etc. Venetia, 1596. 173 p. 4°. Pre-Linn. 1596.1

—— Histoire naturelle et moralle des Indies, tant Orientales qu'Occidentales. Paris, 1598. 375 p. 8°. Pre-Linn. 1598.1

—— Historie naturael ende morael, van de Westersche Indien, etc. Haerlem, 1598. xii, 389 p. 8°. Pre-Linn. 1598.2

—— De novi orbis natura et ratione (In De Bry, Grands Voyages — America, pt. IX, [Text in Latin]. Francofurti, 1602. 362 p.) Pre-Linn. 1602.1

—— Naturall and morall historie of the East and West Indies, etc. Translated by E. G.[rimston], London, 1604. Pre-Linn. 1604.1

Of fishers and the manner of fishing in the Indies, book III, chap. xv, pp. 163–169.

The most available English version is the Hakluyt Society reprint in Works, nos. 60 & 61, bearing the title: "The natural and moral history of the Indies," etc. London, 1880.

Acuña, *Christoval de* [1597—*c.*1655] Nuevo descubrimiento del gran Rio de los Amazonas, i viague de la provincia del Quito en el reyno del Peru. Madrit 1641. 4°. Pre-Linn. 1641.1

Translations into French, English and German are:

—— Rélation de la rivière des Amazones, traduite de l'Espagnole par M. Gomberville. 2 vols. Paris, 1682. 12°. Pre-Linn. 1682.1

—— Voyage and discoveries up the river Amazon to Quito in Peru and back again to Brazil, etc. (In Acuña, C. d', Acarete, ——, Grillet, J., & Bechamel, F. Voyages and discoveries in South America. 3 parts. London, 1698, pt. I, viii, 190 p.) Pre-Linn. 1698.1

Part I, chap. xxv is entitled: "The great plenty of fish in this river [Amazon] and which is the best sort of them."

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[1] Literature of fishes *ante* 1758, the date of the 10th edition of the Systema Naturæ.

—— Reise . . . auf dem Amazonflusse, (1639–40) (In Arkstee, ——, & Merkus, ——, Allgemeine Historie der Reisen, etc., 1758, vol. XVI. 4°.)
Pre-Linn. 1758.1

Acuña's work is available for English readers in the Hakluyt Society reprint, in Works, no. 24 for 1859: "A new discovery of the great river of the Amazons, 1639, etc." In this *see* — Methods of fishing used by the Indians, description of the paraque or electric eel, etc.

Adanson, *Michel* [1727–1806] Histoire naturelle du Sénégal. Coquillages. Avec une relation abregée d'un voyage fait en ce pays, pendant les années 1749–1753. Paris, 1757, viii, 190; xcvi, 275 p. 19 pls. map. 4°.
Pre-Linn. 1749.1

Contains a reference to the electric catfish, Malopterurus (p. 134).
Translated into English as:

Voyage to Senegal, the Isle of Goree, and the river Gambia. London, 1759. 8°.

There are German translations by Martinus, Brandenburg, 1773, and by Schreber at Halle in the same year.

Ad-Damîrî, *Imâm Kamâl-ad-dîn* [1341 or 49–1405] Hayât al-Hayawân. [MS. *c.* 1372]
Pre-Linn. 1372.1

This Arabic natural history lexicon was composed by the author while professor in the University of Al-Azhar at Cairo. It was first printed in Arabic at Cairo, 1858; reprinted Cairo, 1867, 1887, & in 3 other issues before 1903. An illustrated edition (in Persian?) has been issued at Teheran, and a version, presumably in Turkish, at Constantinople. It is most available as:

Ad-Damîrî's Hayât al-Hayawân. (A zoological lexicon.) Translated from the Arabic by A. S. G. Jayakar. 2 vols. London & Bombay, 1906–08.
2nd vol. in 2 parts. Each vol. and part paged separately.
For reference to fishes, *see* indices.

Ælfric (*Archbishop of Canterbury*) [955—*c.*1020] Colloquium [Latine et Saxonice] . . . ab Ælfrico primum compilatum, etc. [MS. *c.* 990].
Pre-Linn. 990.1

The oldest English treatise on fishing is contained in this work.
The original, a MS. of the 10th century, is in the Cottonian collection of the British Museum. Reproduced in Thorpe, B., "Analecta anglosaxonica," 1834, p. 101–118, and 1846, pp. 18–36. *See* also Wright, Thomas, "A volume of vocabularies," etc., 1857.
For an English translation, with many valuable notes on the names of the fishes mentioned, *see* Prof. W. W. Skeat in the "Angler's note-book," 1880, pp. 76–77; 155–156; 168–170.

Ælian, *Claudius* [*fl. c.* 120 A. D.] Ex Æliani historia per Petrum Gyllium latini facti, itemque ex Porphyrio, Heliodoro, Oppiano, tum eodem, Gyllio luculentis accessionibus aucti libri xvi, de vi et natura animalium. Ejusdem Gyllii liber unus, de Gallicis et Latinis nominibus piscium. Lugduni, 1533. 28, 589 p. 4°.
Pre-Linn. 1533.1

Pisces, lib. XI–XIII.
An exceedingly rare and very beautiful edition of this famous work. Other pre-Linnæan editions are: Rome, 1535 or 1545; Zurich, 1555 or 1556; Lyons, 1535 & 1562; Lugduni, 1611; Geneva & Cologne (Gesner & Gilles eds.), 1616; Basel, 1750; London, 1744 — given below.

—— De natura animalium, libri xvii. Cum animadversionibus C. Gesneri et D. W. Trilleri. Curante Abr. Gronovio [Text in Greek and Latin] Londini, 1744. 4°.
Pre-Linn. 1744.1

Of modern editions the best are:

Æliani de natura animalium libri XVII. Græca et Latine cum priorum interpretum et suis animadversionibus edidit J. G. Schneider. 2 vols. [in 1] Lipsiæ, 1784.

Æliani de natura animalium libri septemdecim. Verba ad fidem librorum manuscriptorum constituit et annotationibus illustravit F. Jacobs. Intextæ sunt curæ secundæ postumæ J. G. Schneideri . . . . Adjecti indices et interpretatio Latina Gesneri a Gronovio emendata (. . . Cum addendis et conjuncturis ineditis J. J. Reiskii). 2 vols. Jena, 1832. 8°.
Vol. I contains the Greek text, followed by the Latin translation, which has a distinct pagination; vol. II contains the notes.
There is also a later edition published at Paris by Didot in 1858.

Ælian is the first, and indeed the only writer among the ancients who mentions the use of the artificial fly in fishing for trout. *See* book xv of his history.

Agrippa, *Heinrich Cornelius* [1486–1535] Henrie Cornelius Agrippa, of the vanitie and uncertaintie of artes and sciences. Englished by Ja. Sam. Gent., etc. London, 1569. 4°.
Pre-Linn. 1569.1

Chapter LXXVI of this caustic satire on the kinds of learning in vogue in Agrippa's age is "Of fishing": "The study of fishing was in time past emonge the Romaines in so greate price, and estimation that they did sow in the Italian sea, as it were corne in the ground. . . . Furthermore with great costs they made great fishe pooles and pondes full of most pretious fishes, etc."

Aitzema, *Lieuwe van* [1600–1669] Saken van Staet en Oorlogh, in, ende omtrent de Vereenigde Nederlanden (1621–1669). 's Gravenhage [The Hague], 1669. 6 parts. fol.
Pre-Linn. 1669.1

Contains considerable data about herring fisheries.

Albertinus, *Ægidius.* Der Welt Tummel: und Schauplatz, sampt der bitter-süssen Warheit. Darinn mit Einführung viler schöner und fürtrefflicher Discursen nit allein die natürliche, sondern auch moralische und sittliche

Albertinus, *A.*
Eigenschafften und Geheimnussen der fürnembsten Creaturen und Geschöpff sehr lustig, geist- und politischer Weiss erklärt. München, 1613, xii, 1048 p. 4°. Pre-Linn. 1613.1

Pt. v, Fishes.

Albertus Magnus [1193 *or* 1205–1280] For articles on his life and works, *see* Sighart, J. 1857.1; Stadler, H. 1903.1, 1909.1, Add. 1907.1, 1912.1, 1912.2, 1913.1; also Saintyves, P. in "Revue des traditions populaires." Paris, 1913, 556–564.

For a list of the authorities cited by Albertus in his "De Animalibus," *see* Buhle in Kön. Gesell. Wiss. Göttingen, Commentationes, **12**.

—— De animalibus. Libri xxvi. Rome, 1478. fol. Pre-Linn. 1478.1

This is the *editio princeps*. Almost equally rare is the 2nd edition, the Mantua folio of 1479. Other old eds. are: Venice, 1490, 1495, 1498, 1519; Cologne, 1541 & 1546; Frankfort, 1546. An early German translation is entitled:

—— Thierbuch von Art, Natur und Eigenschaft der Thiere nemlich von Vierfüssigen, Vögeln, Fyschen, Schlangen und Insecten durch Waltherum Ryff verteutschet. Frankfurt-an-Main, 1546. fol. Pre-Linn. 1546.1

—— Opera omnia, edita studio et labore P. Petri Jammy. XXI vols. Lugduni, 1651. fol. Pre-Linn. 1651.1

The most famous edition of Albertus' collected works. Copy, N. Y. P.
Fishes are treated in vol. VI, book xxiv, the title of which reads as follows:

—— De animalibus lib. xxvi. Lugduni, 1651. 684 p. fol. Pre-Linn. 1651.2

For a modern edition of the works of Albertus, consult: "Opera omnia cura Aug. Borgnet edidit. Historia animalium libri xxvi." Parisiis, 1891.

"Albert's work is not such an inorganic compilation as Thomas's. He has paraphrased the ten books of Aristotle's natural histories, his four books on the parts of animals, and his five books on their generation. To these nineteen, he has added seven books on the nature of animal bodies and on their grades of perfection; and then on quadrupeds, birds, aquatic animals, snakes and small bloodless creatures. Besides Aristotle, he draws on Avicenna, Galen, Ambrose (!) and others, including Thomas of Cantimpré. Thus, his work is made up mainly of the ancient written material. Moreover, Albert is kept from a natural view of his subject through the need he feels to measure animals by the standards of human capacity, and learn to know them through knowing man." Henry Osborn Taylor, "The Mediæval Mind," vol. II, p. 429, London, 1911.

Albin, *Eleazer* [1713–1759] The history of esculent fish. London, 1724. 4°. Pre-Linn. 1724.1

To this edition was appended Roger North's "A discourse of fish and fish-ponds" first published 1713.
For another edition, 1794, *see* Albin, E., 1794.1. Copy, A. M. N. H.

—— Icones piscium, cum nominibus latinis, anglicis et gallicis; cum figuris æneis. London, 1735–41. 4°. Pre-Linn. 1735.1

Albrecht, *Johann Sebastian* [1695–1774] Phœnix Germanus, oder Bilderpostill, darim über ein jedes Evangelium ein besonderes Thier vom Vögeln, Fischen, &c. vorgestellet wird. Francfort, 1670. 4°. Pre-Linn. 1670.1

Alciati, *Andrea* [1492–1550] For a biography and an estimate of Alciati's book, *see* Green, Henry, "Andrea Alciati and his book of emblems: a biographical and bibliographical study." London, 1872.

—— Emblemata. Augsburg, 1531. Pre-Linn. 1531.1

Often reprinted — at least 174 eds., 1531–1749. In 1871, the Holbein Society published at Manchester a photolithograph facsimile reprint of the Lyons 1551 edition. The full title seems to be that for the 1581 edition.

—— Omnia emblemata: cum commentariis, quibus emblematum omnium aperta origine, mens auctoris explicatur, & obscura omnia dubiaque illustrantur; per Claudium minoem divionensem. 3rd ed. Antverpiæ, 1581. Pre-Linn. 1581.1

Remora as a ship-stopper, p. 101; 303–304.

Aldrovandi, *Ulisse* [1522–1605 *or* 07] For memoirs, *see* Andres, A. 1908.1; Fantuzzi, G. "Memorie della vita di Ulisse Aldrovandi con alcune lettere scelte d'uomini eruditi a lui scritte, e coll' indice delle sue opere MSS. che si conservano nella biblioteca dell' instituto." Bologna, 1774. portr. 8°; and Macgillivray, W. in Jardine's Naturalist's Library, 1845–46, Mammalia, vol. III.

—— De piscibus libri v, et de cetis liber unus. Bononiæ, 1613. iv, 732 [26] p. illust. fol. Pre-Linn. 1613.1

1st ed. Others are: Venice, 1614, 1616; Frankfort, 1623, 1629, 1640; Bologna, 1625, 1638 (2 eds.), 1642, 1644.

—— Monstrorum historia, cum paralipomenis historiæ omnium animalium.

Bartholomæus Ambrosinus labore et studio volumen composuit. Bononiæ, 1642. Pre-Linn. 1642.1

Monstrosus cyprinus, p. 352. Monstrosus sus marinus, p. 353. Piscis biceps, p. 428. Paralipomena historiæ, Piscium & Ceterorum, pp. 54–98.

— Musæum metallicum in libros IIII. distributum. B. Ambrosinus . . . composuit . . . M. A. Bernia . . . in lucem edidit, &c. Bononiæ, 1648. iv, 979, 13 p. illust. fol. Pre-Linn. 1648.1

Fossil fishes, p. 102–104. 453–454, 764. Ray spine, p. 490. De glossopetra (sharks' teeth), p. 600–606. De ceraunia (sharks' teeth), p. 606–612. Lapis auratæ piscis et tiburonis, pp. 796–798.
Another edition is:

—— Synopsis musæi metallici . . . edita â D. Kellnero. Lipsiæ, 1701. 258 p. 12°. Pre-Linn. 1701.1

Aldrovandi, professor of philosophy and medicine at Bologna, spent his life and fortune in collecting materials for a gigantic natural history which was intended to cover the whole field as it had not been done even by Conrad Gesner. Five volumes had been published at the time of his death, and the other eight were published posthumously under the editorship of Joannes Cornelius Uterverius.

Alischer, *Sebastian.* De carpione hermaphroditico, oder von einer Karpfe, so Milch und Rogen gehabt. Natur u. Kunstgesch., Breslau, 1720, **14**, 645. Pre-Linn. 1720.1

Allamand (*junior*), *Jean Nicola Sebastian* [1713–1787] Kort verhaal van de uitwerkzelen, welke een Americaanse vis veroorsaakt op de geenen die hem aanraaken. Verhandl. Hollandsch. Maatsch. Wetensch. Haarlem, 1756, **2**, 372–379. Pre-Linn. 1756.1

"Piscis ex Gymnoti genere in America Meridionali frequens, effectus tales prodit quos Torpedo in Italia."
Also found in Hannov. Samml., 1756, 2. Th., 27. St. — Hamb. Mag., 1756, **2**, 178. Abstract in Comment. Lips., 1756, **8**, 396.

Allen, *Benjamin.* Of the manner of the generation of eels. Phil. Trans. Roy. Soc., 1697 (1698), **19**, no. 231. Pre-Linn. 1698.1

Alpinus, *Prosper* [1553–1616 *or* 17.
—— Travels in Egypt (In Ray, John] A collection of curious travels and voyages, etc. 2 vols. [in 1] London, 1693, xxvii, 396, 186, 45 p. 8°.) Pre-Linn. 1693.1

Alpinus's travels are found in vol. II. This "collection" was reprinted in 1738.
A separate publication is:

—— P. Alpini . . . Historiæ Ægypti naturalis pars prima (- secunda) . . . Opus postumum. etc. Lugduni Batavorum [Leyden], 1735. 248, 306 p. 25 pls. 4°. Pre-Linn. 1735.1

Fishes, pp. 201–203.
Other editions: Venice, 1591; Lyons, 1619 (in French); Padua, 1639. Alpinus's travels are also included in vol. II of:

—— (Ray, John. Travels through the Low Countries, etc. To which are added a collection of curious travels etc. . . . collected from the observations of . . . P. Alpinus . . . and others. 2nd. ed. 2 vols. London, 1738) Pre-Linn. 1738.1

Alpinus, professor and prefect of the University of Padua, was Venetian consul at Cairo, 1580–1584. The original edition of his "Travels" is not known.

Ambrose, (*Saint*) [*c.* 340–397] Hexæmeron de principis rerum libri VI. Augustæ Vindelicorum [Augsburg], 1472. fol. Pre-Linn. 1472.1

This is the much prized 1st ed. Copies; L. C., & H. E. H.
Another ed. is dated *c.* 1481. A later ed. is listed below.

—— Opera. 3 vols. Basel, 1492. fol. Pre-Linn. 1492.1

Fishes, vol. I, book v.
Other eds.: Lugduni, 1559; Paris, 1686–90. 2 vols. fol.

—— Divi Ambrosii, Mediolanensis episcopi, Hexæmeron libri VI. Basileæ, 1566. 88 p. fol. Pre-Linn. 1566.1

The names of a score of fishes are given in book v., but no descriptions are added.

Ambrosius, *Divus* (*Bishop of Milan*). *See* **Ambrose,** *Saint.*

Anderson *or* **Andersen,** *Johann* [1674–1743] Nachrichten von Island, Grönland und der Strasse Davis, zum wahren Nutzen der Wissenschaften und der Handlung. Nebst einem Vorberichte von den Lebensumständen des Herrn Verfassers. Hamburg, 1746. xxx, 333 p. 5 pls. map. 8°. Pre-Linn. 1746.1

This work, which contains considerable data about fishes, passed through many editions: Frankfort and Leipsic, 1747; Copenhagen, 1748; Paris, 1750, 1754, 1764; Amsterdam, 1750, 1756; London, 1758. fol.
Danish & Dutch versions are:

—— Efterretninger om Island, Grönland og strat Davis, med en tilgift som videre efterretning om Island. Kjöbenhavn, 1748. 356 p. pls. 8°. Pre-Linn. 1748.1

—— Beschryving van Ysland, Groenland en de Straat Davis . . . Benevens

Anderson, *J.* een voorbericht, bevattende levensbyzonderheden van den Schryver. Uit het hoogduitsch verstaalt. Amsterdam, 1750, xvi, 286 p. 6 pls. 4°.
Pre-Linn. 1751.1

See also note under Horrebow, N., Pre-Linn. 1758.1

Andrew, *Laurence.* The wonderful shape and nature of man, beastes, serpentes, fowles, fishes, and monsters, translated out of divers authors, by Laur. Andrew, of Calis. Antwerp, 1510. ills. fol. (*black letter*)
Pre-Linn. 1510.1

Anglicus, *Bartholomew.* *See* **Bartholomæus Anglicus.**

Ankarkrona, *Theodore* [1687–1750] Beschreibung des Fünffingerfisches. Abhand. Schwed. Akad., 1740, **2**, 242–245. pls. Pre-Linn. 1740.1

See note under Kästner, A. G., in this section.

—— Beskrifning ofver famfingers fisken. Svensk. Vetensk. Akad. Handl., Stockholm, 1740, **2**, 457.
Pre-Linn. 1740.2

Describes *Coryphæna pentadactylus* Bloch.

Antonius, *G.* (*præses*) Disputatio juridica de jure venandi, aucupandi et piscandi. Inaug. Dissert. Marpurgæ, 1604. 3 pls. 4°. Pre-Linn. 1604.1

Jacobus Ninmero, *respond.*

Aquinas, (*Saint*) *Thomas* (*surnamed Doctor Angelicus*) [*c.* 1225–1274] For a brief account of the life and works of this learned man, and for a list of biographies and editions of his books, *see* Martin, T. L., & Mitchell, J. M. in Encyclopædia Britannica, 11th ed., 1910, vol. II, p. 250–252.

—— Summæ theologicæ. Partes III. Basel, 1485. Pre-Linn. 1485.1

Clupeoid fishes named Sarda and Harenga are mentioned in connection with canonizing ceremonies. The first of these names occurs also in Isidore and seems to refer to the sardine.

An early ed. of the complete work. Issued in 3 parts separately and in fractions of these parts as well as a whole from 1467 ("Partes secundæ; secunda pars," Mainz) on, this work passed through a great number of editions and translations. Of 15th century issues alone there are, of the whole work, or of its parts, in America alone, 32 eds. For these, *see* "Census of 15th Century Books in America."

The best modern eds. of the "Summæ Theologicæ" are that of Rome, 1882–1903 (prepared at the expense of Leo XIII); and one in English by J. M. Ashby. London, 1888.

Arctædius, *Petrus.* *See* **Artedi,** *P.*

Arctander, *Sever.* (*respond.*) Piscis ille grandissimus, qui Jonam integrum devoravit. Hafniæ, 1698. 4°.
Pre-Linn. 1698.1

Johannes Beenius, *præses.*

Arderon, *William* [1703–1767] A letter concerning the perpendicular ascent of eels. Phil. Trans. Roy. Soc. 1747 (1748), **44**, 395–396.
Pre-Linn. 1748.1

—— A letter containing some observations made on the bansticle, or pricklebag, alias prickle back, and also on fish in general. Phil. Trans. Roy. Soc., 1747 (1748), **44**, 424–428.
Pre-Linn. 1748.2

—— A letter on keeping of small fish in glass jars, and of an easy method of catching fish. Phil. Trans. Roy. Soc., 1746 (1748), **44**, 23–27. — Hamburg. Mag., [1748?], **2**, 482.
Pre-Linn. 1748.3

The method of catching fish is one adopted at a small country town near Norwich, wherein worms, enclosing a thorn, are attached by threads, in hundreds, to the bushes overhanging a stream, for the purpose of catching the fish.

—— A letter concerning the hearing of fish. Phil. Trans. Roy. Soc., 1748 (1750), **45**, 149–155. — Hamburg. Mag., 1750, **5**, 655–663. Pre-Linn. 1750.1

—— [Observations on keeping fish in glasses.] Phil. Trans. Roy. Soc., 1748 (1750), **45**, 321–323. fig.
Pre-Linn. 1750.2

First known reference to fungus parasitic on fish.

Argenville, *Ant. Jos. Dezallier d'* [1680–1765] L'histoire naturelle . . . l'oryctologie, qui traite des terres, des pierres, . . . et autres fossiles, etc. Paris, 1754. 560 p. pls. 4°.
Pre-Linn. 1754.1

American fishes engraved from Plumier's drawings, pl. 26, figures 1–4.

Fossil fishes figured, pl. 18; listed, pp. 334–341; 350–353.

Another ed., Paris, 1755. Copy 1754 ed., Col.

Argillander, *Abraham.* Rön om Gjädd-leken. K. Svensk. Vetensk. Acad. Handl., 1753, **15**, 74–77.
Pre-Linn. 1753.1

—— Untersuchung vom Laichen des Hechtes. König. Schwed. Akad. Abhandl., 1753, **15**, 77–79. — Hollands. Mag., 1753, **2**, 569. Notice in Comment. Lips., 1753, **5**, 10. Pre-Linn. 1753.2

See note under Kästner, A. G., this section.

Aringhi, *Paul.* Roma subterranea. 2 vols. Paris, 1659. 352 & 396 p. illust. fol. Pre-Linn. 1659.1

Fishes are dealt with. An earlier edition(?), 1651.

Aristotle [384–322 B. C.] For a memoir, *see* Crichton, Andrew, (In Jardine, (Sir) W. Naturalist's Library, 1836, vol. XIV, p. 17–112. *Ibid.*, [2nd issue], 1845–46.)

For critical commentaries on the work of the "Father of Natural History," *see* Agassiz, L. 1856.2, 1858.9, 1871.1; Burckhardt, C. R. 1905.2; Girod, P. 1880.1; Klunzinger, C. B. 1901.1; Scupin, E. 1905.1; Sonnenburg, L. 1857.1; Steier, A. 1913.2; Sundevall, C. J. 1863.1; Thompson, D. W. 1913.1; Vallot, J. N. 1838.1, 1839.1; Wiegmann, A. 1826.1. Also, Biese, F. Add. 1835.1; Camus, A. G. Add. 1783.1; Gill, T. N. Add. 1873.1; Heck, L. F. Add. 1885.1; Jourdain, A. Add. 1843.1; Langkavel, B. Add. 1863.1; Lewes, G. H. Add. 1864.1; Meyer, J. B. Add. 1855.1; Osborne, J. Add. 1840.1.

—— Aristotelis de animalibus libri IX; de partibus animalium libri IV; de generatione animalium libri V. Latine, interprete [Theod.] Gaza. Venetiis, 1476. fol. Pre-Linn. 1476.1

The first printed edition of any of Aristotle's "Natural History." Other editions of this: Venice, 1492, 1498, & 1503. Copies in H., Y., L. C., H. E. H.

—— Historia animalium latine, Th. Gaza interprete. Venetiis, 1492. Pre-Linn. 1492.1

A 2nd ed. of the above is dated Venice, 1498. Another ed., augmented by the works of other natural history writers, appeared at Venice in 1513.

—— Opera omnia. 4 vols. Augsburg, 1479. fol. Pre-Linn. 1479.1

The first Latin edition of the "Opera." Other early Latin eds. are: Venice, 1489, 1496, 1550–52 (11 vols. fol.). Copies: H., P., J. H. U., U. C., H. E. H.

—— Opera omnia et nonnulla græce. Aldus Manutius editor. 5 vols. Venetiis, 1495–1498. fol. Pre-Linn. 1495.1

The first Greek edition of Aristotle's works. Other eds. in Greek of the complete works are: Basle, 1531, 1550.

During the 15th century, six editions of the "Opera," the "Historia" or its parts, appeared at Venice; 1476, 1492, 1493, 1495, 1497, 1498. Of the same the 16th century saw at least 5 editions from Venice; as many from Paris; 4 from Leyden; 2 from Basel; and one each from Cologne, Florence, and Lyons. During the 17th and first half of the 18th centuries, editions appeared too numerous to be listed. Of comparatively recent editions, the following may be cited as standard:

Aristoteles Græce; ex recensione I. Bekkeri, etc. Edidit Academia Borussica. 5 vols. Berolini, 1831–70. 4°.

Aristoteles Thierkunde: Kritischberichtigter Text mit Deutscher Uebersetzung . . . und Sprachlicher Erklärung . . . von H. Aubert und . . . F. Wimmer. 2 Bd. Leipzig, 1868. illust. 8°.

Histoire des animaux d'Aristote traduite en Français et accompagnée de notes perpétuelles par J. Barthélemy-St.-Hilaire. 3 tom. Paris, 1883. 8°.

The works of Aristotle translated into English under the editorship of J. A. Smith, and W. D. Ross. Vol. IV. Historia animalium by D'Arcy Wentworth Thompson. Oxford, 1910. xv, folios 486a – 633a + index. 8°.

This is the best English translation, far superior to that by Thomas Taylor (1806.1) or that by Creswell (1883.1). For a critical estimate of both the two earlier English and of Thompson's newer version, *see* Gill, T. N. 1911.1.

Arkstee, ——, & **Merkus,** ——. Allgemeine Historie der Reisen zu Wasser und Lande; oder Sammlung aller Reisebeschreibungen welche bis itzo in verschiedenen Sprachen von allen Völkern herausgegeben worden . . . Durch eine Gesellschaft gelehrter Männer im Englischen zusammen getragen, und aus demselben ins Deutsche übersetzet. 21 vols. Leipzig, 1747–74. illust. 4°. Pre-Linn. 1747.1

"This work is a translation and extension of 'A new general collection of voyages and travels, etc.,' 1745–47, as well as of A. F. Prévost's 'Histoire générale des voyages.' The translation was begun by A. G. Kästner and J. J. Schwabe, and carried on by F. W. Beer, C. C. Woog, J. G. Müller, F. J. Bierling, and others." — Catalogue British Museum (Natural History).

Armstrong, *John* [–1758] The history of the Island of Minorca. London, 1752. xxvii, 260 p. 2 pls. 8°. Pre-Linn. 1752.1

Glossopetras, pp. 142–143. figs. Fishes, pp. 161–169.

2nd. ed., London, 1756. A French version is:

Histoire naturelle et civile de l'isle de Minorque, traduite sur la deuxième édition anglaise. Amsterdam & Paris, 1769. 2 pls. map. 12°.

There is also a German translation, Hamburg, 1771; while another appeared in the Göttingische Sammlung der Reisen.

Arnault de Nobleville, *Louis Daniel* [1701–1778], & **Salerne,** *François.* Traité d'histoire naturelle des animaux, pour servir de suite à la matière médicale de Geoffroy. 7 vols. Paris, 1756–1757. 12°. Pre-Linn. 1756.1

14 fishes described, vol. II, p. 347. Refers to fishes in medicine. Deals with voracity of pike, viviparity of eels, etc.

Arnold, *Theodorus.* (*translator*). Eine Untersuchung des Ursprungs, und der

Arnold, *T.*
Formirung der Fossilien, oder Fischeschalen und anderer dergleichen Cörper so aus der Erden gegraben werden, . . . die zwo unterschiedenen Meynungen, nehmlich dererjenigen, die solche vor die Exuvias, oder hinterlassene Schalen würcklicher Fische ausgeben, und derer, die sie vor Lusus Naturæ oder ein blosses Spiel der Natur halten, zu vergleichen. Leipzig, 1732. 8°. Pre-Linn. 1732.1

Arrian, *Flavius* [*fl.* 2. cent. A. D.] Historia [Greek]. Pisauri [Pesano], 1508. fol. Pre-Linn. 1508.1

Other eds. Basel, 1539; Venice, 1544 (Italian).

"Arrian's History furnishes us with some interesting details of an almost exclusively ichthyophagous community in India, and their wonderful skill, both in the manufacture and the use of nets made from the inner bark of palm-trees." — J. J. Ripley, 1883.

—— De venatione. Græce et Latine; Luca Holstenio interprete. Parisiis, 1644. 4°. Pre-Linn. 1644.1

Artedi, *Peter* [1705–1735] For biographies, *see* Eastman, C. R. 1905.5; & Lönnberg, A. J. 1905.7.

—— Ichthyologia, sive opera omnia de piscibus scilicet: Bibliotheca ichthyologica. Philosophia ichthyologica. Generum piscium. Synonymia specierum. Descriptiones specierum. Omnia in hoc opere perfectiora, quam antea ulla. Posthuma vindicavit, recognovit, coeptavit et edidit Carolus Linnæus. 5 parts. Lugduni Batavorum [Leyden], 1738. 8°. Pre-Linn. 1738.1

The separate parts of this work are thus entitled:

Pars i. Bibliotheca ichthyologica sive historia litteraria ichthyologiæ in qua recensio fit auctorum, qui de piscibus scripsere, librorum titulis, loco & editionis tempore, additis judiciis, quid quisvis auctor præstiterit, quali methodo et successu scripserit, disposita secundum sæcula in quibus quisvis auctor floruit. iv, 66 p.

Pars ii. Philosophia ichthyologica in qua quicquid fundamenta artis absolvit, characterum scillicet genericorum, differentiarum specificarum, varietatum et nominum theoria rationibus demonstratur, et exemplis corroboratur. iv, 118 p.

Pars iii. Genera piscium. In quibus systema totum ichthyologiæ proponitur, cum classibus, ordinibus, generum characteribus, specierum differentiis, observationibus plurimis. Redactis speciebus 242 ad genera 52. iv, 88 p.

Pars iv. Synonymia nominum (specierum) piscium fere omnium; in qua recensio fit nominum piscium, omnium facile authorum, qui unquam de piscibus scripsere: uti Græcorum, Romanorum, barbarorum, necnon omnium insequentium ichthyologorum una cum nominibus inquilinis variarum nationum. iv, 118 p.

Pars v. Descriptiones specierum piscium quos vivos præsertim dissecuit et examinavit, inter quos primario pisces Regni Suecia facile omnes accuratissime describuntur, cum non paucis aliis exoticis. iv, 102 p.

"Artedi may be justly regarded as the father of modern ichthyology, having introduced a precise terminology, full and pertinent diagnoses, and throughout uninominal generic names." — T. N. Gill, Smithson. Misc. Coll., 1872 (1874), no. 247, p. 28.

The subsequent editions of Artedi's work by Walbaum (1788–1793) and J. G. Schneider (1789) are noticed under the editors' names.

Ascham, *Anthony* [*fl.* 1553] A prognosticacion and an almanacke joyned together declaryng the disposition of the people, and also of the wether, with certayne electyons and tymes chosen . . . for hawekyng, huntyng, fishyng and fowlyng, accordyng to the science of astronomy, made for the yeare of our Lorde God, MDL. London [1549] Pre-Linn. 1549.1

Ash, *Thomas.* Carolina; or a description of the present state of that country, etc. Published by T. A[sh] gent. London, 1682. Pre-Linn. 1682.1

Among the fishes mentioned are sturgeon, mullets, salmon, trout, bass, drum, cat-fish, plaice and eels.

Asseler, *Thomas.* Viridarium adriaticum; oder, der, um den venetianischen golfo, florierende lust-garten in welchem zu sehen seyn die schône blumen &c., dero inligender insulen, allerseits, angråntzender lånder, vornembste stådt, gewåchs, frůchten, thier &c. vorgestellt. Augspurg, 1686. 110 p. 19 pls. maps. 16°. Pre-Linn. 1686.1

A few fishes described. Copy, Arn.

Athenæus, *Naucratita* [*fl. c.* 200] For an essay on this author and the fishes referred to in his work, *see* Wellmann, 1888.1.

—— Deipnosophistarum libri xv. Venice, 1514. fol. Pre-Linn. 1514.1

This, the *editio princeps*, is in Greek. Better known is the famous edition of 1524. Another very famous edition is:

—— Athenæi Deipnosophistarum lib. xv, cura et studio Isaaci Casuboni . . . auctiores emendatioresque editi. Cum interpretatione latina Jacobi Dalechampii, Cadomensis. Adjecti sunt indices rerum, scriptorum, proverbiorum, vocum accuratissimi. Heidelbergæ, 1597. 702 p. fol. Pre-Linn. 1597.1

Other early eds. are: Basel, 1535 (in Greek), 1556; Venice, 1556 (apparently the 1st Latin edition); Lyons, 1583, 1600, 1612, 1621, 1657, 1661; Geneva, 1597.

—— Les xv livres de Deipnosophistes d'Athenée, traduits du grec en françois; par l'Abbé de Marolles. Paris, 1680. 4°. Pre-Linn. 1680.1

This is the best old edition issued at Paris. Other French editions are those of 1798, and that of 1819 in three volumes translated by Lefevre Villebrune.

Of modern issues, the one considered by Cuvier and by Brunet to be the best is that issued at Strassburg in 14 vols. by Schweighauser, 1801–07. A later edition and probably the best of all is that by Kaibel issued 1887–90.

An English translation by C. D. Yonge is to be found in Bohn's Classical Library, London, 1884, under the title "The deipnosophists or the banquet of the learned." In this translation, vol. I, book III, chaps. LXXXV-XCIV, fish as food; vol. I, book VI, chaps. I-XII, fishmongers and fishermen; vol. II, book VII, chaps. IV-CXL, some 85 or more fishes are referred to; book VIII, voices of fishes, fossil fishes, subterranean fishes, rain of fishes, fish eaters, restoration after freezing, sounds made by fishes, migration of fishes, amphibious fishes, particular fishes used for food, etc.

Athenæus, a Greek rhetorician of Naucratis, Egypt, was author of a number of works of which "The Banquet of the Learned" only is extant. It is an immense storehouse of miscellaneous information written in the form of the table talk of a number of writers and philosophers who were entertained at a great banquet by a wealthy patron of art and literature. Its great value is due to the fact that it is full of quotations from writers whose works are no longer extant, and who but for Athenæus, would be lost to us. He quotes 800 authors and 2500 separate writings.

"As a work of art it [the Deipnosophistarum] can take but low rank, but as a repertory of fragments and morsels of information, it is invaluable."

Aurivillius, *Joh.* (*respond.*) Dissertatio de natura piscium in genere, et piscatura. Holmiæ, 1676. 4°. Pre-Linn. 1676.1

Magnus Celsius, *præses.*

Ausonius, *Decius Magnus* [310–395] Ausonii Burdigalensis, viri consularis Mosella, edyllium tertia. Burdigale, 1580. fol. Pre-Linn. 1580.1

This idyll, entitled the "Mosella," was written about 370 A. D. It contains recognizable descriptions of the species of fish found in the Moselle, among them the brook and salmon trout.

—— Mosella . . . commentario illustrata. Mussiponti, 1615. 8°. Pre-Linn. 1615.1

A black letter edition with commentaries by Focher was printed at Heidelberg, 1619, in folio.

—— Opera. Venice, 1472. fol. Pre-Linn. 1472.1

The "Opera" of Ausonius have appeared in many editions of which this is the first. At least 10 editions are known *ante* 1758, the three earliest being; 1472, 1494, 1496. For further bibliographical details, *see* Westwood & Satchell.

The "Mosella" is contained also in "Poetarum Latinorum minorum," vol. I, p. 192, edited by Johann C. Wernsdorff, Altenburg, 1780.

Oken in Isis, 1845, columns 5–44, reprints the "Mosella" with a parallel German translation. He then identifies the 16 fishes of Ausonius, and gives many references to these fish in the writings of 16th and 17th century authors.

There is also a modern annotated edition by Hosius, published at Marburg in 1894, commented upon by J. Wimmer in his "Geschichte des deutschen Bodens," p. 322–384. Halle, 1905.

Modern editions of the Mosella in Latin and German were issued: Coblenz, 1802; Hamm, 1824; Berlin, 1828; Altona, 1832, and Cologne, 1837. The best German edition is probably that of Neumann, Trier, 1846; the best French, by Corpet, Paris, 1843.

B

B., *A. P. F.* Abentheuer von allerhand Mineralien, . . . Thieren, Vögeln, Fischen, . . . etc. Francofurti, 1656. 4°. Pre-Linn. 1656.1

Bacon, *Francis* (*Viscount St. Albans*) [1561–1626] Sylva sylvarum, or a naturall historie, in ten centuries. London, 1627. portr. fol. Pre-Linn. 1627.1

Other eds.: London, 1635, 1639, 1650, 1658, 1670, 1676 (10th ed.), 1677; Paris, 1631; Leyden, 1648; Amsterdam, 1661. Frequently reprinted since, especially in collected works, as: New York, 1864. 15 vols.
In the 14th ed. — Concerning marine fishes transferred to fresh water, p. 414; concerning scaly fishes, p. 535; fishes in general, pp. 103, 449, 493.

Baeck, *Abraham* [1713–1795] De cornu piscis plane singularis carinæ navis impacto observatio. Acta Acad. Caes. Nat. Cur., 1748, **8**, 199–217. Pre-Linn. 1748.1

Found also in Klein, J. T. in this section, 1740.1 (v. part).

Baerle, *Caspar*. *See* **Barlaeus,** *Caspar*.

Baker, *Henry* [1698–1774] [A letter concerning an extraordinary fish called in Russia quab [*Gadus lota* ?] and on the stones called carp's eyes.] Phil. Trans. Roy. Soc. London, 1748, **45**, 174–180. Pre-Linn. 1748.1

Balbinus, *Bohuslai*. Miscellanea historica regni Bohemiæ. 2 vols. Pragæ, 1679–1682. fol. Pre-Linn. 1679.1

De piscibus Bohemiæ, vol. I, cap. 52–57.

—— Curiosa naturæ Arcana inclyti Regni Bohemiæ, etc. Pragæ, 1724. fol. Pre-Linn. 1724.1

Baldigara, *Battista*. Ragionamento di meraviglis non mai dato in luce. Opera nuova, nella quale si tratta di pesci meravigliosi, che si trovano in diverse peschiere di acque dolci e salse, . . . delle guerre et armate da mare. Venezia, 1752. 8°. Pre-Linn. 1752.1

Baldner, *Leonhard*. For accounts of the man and his book, *see* Bleicher, ——. 1888.1; and Lauterborn, R. 1901.1.

—— Recht natürliche Beschreibung und Abmahlung der Wasser-Vögel, Fischen, vierfüssigen Thier, Insekten und Gerwirm, so bey Strassburg in den Wassern sind, die ich selber geschossen und die Fisch gefangen, auch alles in meiner Hand gehabt. Leonhard Baldner, Fischer undt Hagmeister in Strassburg gefertigt worden. Strassburg, 1666. Pre-Linn. 1666.1

Two modern reprints have appeared. The first by Fr. Reiber is:

L'histoire naturelle des eaux Strasbourgeoises de Léonard Baldner (1666). Bull. Soc. Hist. Nat. Colmar, 1887, 1–114.
A modern German version with copious annotations, was published by R. Lauterborn under the following title:

Des Strassburger Fischers, aus dem Jahre 1666. Vogel- Fisch- und Tierbuch. Herausgegeben mit Einleitung und Anmerkungen. Ludwigshafen, 1903, xvi, 177 p.

The original MS. of this work, which is still extant in the Strassburg Public Library, bears this title:
Descripsit & depinxit pisces & aves, quæ in Rheno & circa Argentoratum reperiuntur. MSC coemit eques Willoughby, et passim inseruit Ornithologiæ suæ & Ichthyographiæ.

Balduin, *Gottfried* (*respond.*) Exercitatio de generatione piscium. Wittebergæ, 1667. 4°. Pre-Linn. 1667.1

Gottfried Thilo, *præses*.

Balk, *Laurentius*. Museum Adolpho-Fridericianum (In Linnæus, C. Amœnitates Academicæ seu dissertationes variæ, etc. Lugduni Batavorum, 1749, **1**, 556–610. 2 pls.) Pre-Linn. 1749.1

Fishes, p. 589–604.
This first appeared as a thesis, Holmiæ, 1746. 48 p. 2 pls. Later in another ed. of the above, Erlangen, 1787.

Bapst, *Michael*. Wunderbares Leib- und Wundarzneybuch. 2 parts. Mülhausen, 1590. 8°. Pre-Linn. 1590.1

Blood of fishes considered. 2nd. ed., Eisleben 1597. 4°.

Baralis, *Barth.*, & **La Chambre,** *Fr. de*. Ergo carnes piscibus salubriores. Paris, 1655. Pre-Linn. 1655.1

Title from Boehmer. Probably a medical dissertation.

Barbarus, *Hermolaus* [1454–1495] Castigationes Plinianæ; emendatio in Melam Pomponium [Rome ?] 1492.
Pre-Linn. 1492.1

Other rare editions (some augmented by other inclusions) are: Rome, 1493; Milan, 1494; Cremona, 1495 & 1497; Venice, 1495; and Basel, 1534. Copies, 1492, 1493, 1495 eds. Y., L. C., U. C.

—— Compendium scientiæ naturalis ex Aristotele. Venetiis, 1545. iii, 76 p.
Pre-Linn. 1545.1

—— Naturalis scientiæ totius compendium, ex Aristotele & aliis philosophis, H. Barbaro . . . auctore, innumeris, quibus antea scatebat, mendis nunc demum D. C. Gesneri . . . opera ac studio purgatum. Cui accessit, H. Wildenbergii Aurimontani in universam Aristotelis Physicam epitome. Basileæ, 1548. 267 p. text ills. 8°.
Pre-Linn. 1548.1

For this author as editor of Pliny's "Historia Naturalis," *see* Barbarus, H. 1778.1.

Barbot, *Jean* [–1720] A description of the coasts of North and South Guinea; and of Ethiopia Inferior . . . containing a geographical . . . and natural history of the kingdoms, etc. (In Churchill, A., & J. Collection of voyages and travels, etc., vol. V. London, 1732. fol.) Pre-Linn. 1732.1

Descriptions and figures are given "of the several sorts of fish in the sea of [South] Guinea." There are also some notes on the habits of fishes, particularly of sharks and the remora.
Another edition, London, 1740.

—— Abstract of a voyage to Congo river, or the Zair, and to Cabainde, in the year 1700. (In Churchill's Collection of voyages, 1746, vol. II, 497–590.)
Pre-Linn. 1746.1

Baricelli, *J. C.* Pisces marinos salubriores et sapidiores esse fluminum piscibus (In his Hortulus genialis. Bologna, 1617. 12°.) Pre-Linn. 1617.1

Other eds.: Bologna, 1621; Genève, 1623.

Barker, *Thomas* [*fl.* 1651] For biographical and bibliographical data of Barker and his books, *see* Westwood & Satchell, 1883.1; and Marston, R. B. 1894.1.

—— Art of angling, wherein are discovered many rare secrets very necessary to be known by all that delight in that recreation. London, 1651. 12°.
Pre-Linn. 1651.1

Reprints appeared at London, 1653 & 1654. The 1651 version was again reprinted at London, 1820; the 1653 volume at Leeds, 1817. The standard edition, the true second, is:

—— Barker's delight, or the art of angling. Wherein are discovered many rare secrets very necessary to be known by all that delight in that recreation, both for catching the fish, and dressing thereof. 2. ed. London, 1657.
Pre-Linn. 1657.1

Copy, N. Y. P.

Barlaeus *or* **Baerle,** *Caspar* [1584–1648] Rerum per octennium in Brasilia et alibi nuper gestarum, sub præfectura illustrissimi comitis J. Mauritii, Nassoviæ, etc. Amstelodami, 1647. 12, 340 p. fol. Pre-Linn. 1647.1

1st ed. A second was issued with Piso's tract on the air, water and localities in Brazil. Clive, 1660. 8°.
Describes some Brazilian fishes.

Barlow, *Francis* [1626?–1702] Severall wayes of hunting, hawking, fishing, according to the English manner, invented by Franc. Barlow, etched by W. Hollar. London, 1671. 12 pls. obl. 4°. Pre-Linn. 1671.1

The plates drawn by Barlow were etched by Hollar, who by some bibliographers is listed as joint author.

Barlow, *William.* A paper concerning the *Mola salviani* or sun-fish, and a glue made of it. Phil. Trans. Roy. Soc. London, 1740 (1744), **41**, 343–345. pl.
Pre-Linn. 1744.1

Barnes *or* **Bernes** *or* **Berners,** *Juliana* or *Julyans* [*c.* 1388–] Treatyse perteynynge to hawkynge, huntynge, and fysshynge with an angle: and also a ryght noble treatise of the lygnage of cot armours, endynge with a treatise which specyfyeth of blasynge of armys. Westmestre, 1496. fol. (*black letter*)
Pre-Linn. 1496.1

The authorship of "The Book of St. Albans" is generally ascribed to Dame Barnes, who is said to have been Prioress of Sopwell near St. Albans. This work is supposed to have been written early in the 15th century, but the first edition of it, which is entitled: "The bookys of haukyng and huntyng: and also of cootamuris. Compylyt at St. Albons, 1486," contains nothing about fishing. The next edition (1496) contains the famous treatise on fishing, the earliest in the English language.

The "Treatyse" was republished in separate form about the year 1500 and at least fifteen editions of the whole work appeared before 1600, most of them being undated.

For careful descriptions and critical discussions of the various early editions of this old work, *see* Westwood and Satchell's invaluable "Bibliotheca piscatoria," p. 24–29 (1883.1); also Lowndes, W. T., "A Bibliographer's Manual of English Literature" revised and extended by H. G. Bohn, vol. I, 1864, pp. 117–118. For an analysis of the "Treatyse of fyshynge with an angle," with extensive quotations, *see* Marston, R. B. 1894.1, p. 15–32. For a critical discussion of "The Book of St. Albans," reference may be made to Haslewood, J., 1810.1.

Barnes, *J.*

—— A jewell for gentrie. Being an exact dictionary, or true method, to make any man understand all the arts, secrets, and worthy knowledges belonging to hawking, hunting, fowling and fishing . . . London, 1614. 50 leaves. 4°. Pre-Linn. 1614.1

This work, published anonymously, is a plagiarized edition of the "Book of St. Albans." Copy in N. Y. P. is listed under Berners.

For a verbatim et literatim et punctuatim reprint of the 1496 edition, *see*:

The book containing the treatises of hawking, hunting, coat-armour, fishing and blasing of arms; as printed at Westminster by Wynkyn de Worde, 1496 [With biographical and bibliographical notices by Joseph Haslewood] London, 1810. illust. 8°.

Another reprint was issued at London in 1827, and especially notable is the facsimile issued at London in folio in 1880 with an introduction by M. G. Watkins. (*See* Barnes, Juliana. 1880.1.)

An American edition of the "Treatyse" was published in New York, in 1875, under the editorship of George W. van Siclen. Other reprints have been issued since this date; *i. e.*, London, 1903, but need not be listed. Of interest, however, is the following:

An older form of the Treatyse of fysshynge wyth an angle attributed to Dame Juliana Barnes. Printed from a MS, in the possession of Alfred Denison; with preface and glossary by Thomas Satchell. London, 1883. (4), viii, 38, (10) p.

"The 'Treatyse' as given in this MS. differs considerably in orthography, phrase, and sense, from that in the 'Boke of St. Albans,' and Professor Skeat is inclined to assign to it an earlier date than 1450." — Dict. Nat. Biog.

Barrère, *Pierre* [1690?–1755] Essai sur l'histoire naturelle de la France équinoxiale, ou dénombrement des plantes, des animaux et des minéraux qui se trouvent dans l'île de Cayenne, les îles de Remire, sur les côtes de la mer et dans le continent de la Guyane; avec leurs noms différents, latins, français et indiens, et quelques observations sur leur usage dans la médicine et dans les arts. Paris, 1741. xxiv, 215 p. 8°. Pre-Linn. 1741.1

Fishes, pp. 169–172.

Another edition, identical save for changed title page, Paris, 1749. For a preliminary notice of this work, *see* Mém. Acad. Sci. Paris, 1741 (*Hist.*, p. 23). A partial translation is: "Neue Beschreibung von Guiana." Göttingische Sammlung der Reisen, 2. Bd.

—— Nouvelle relation de la France équinoxiale, contenant la description des côtes de la Guyane; de l'isle de Cayenne; le commerce de cette colonie; les divers changemens arrivés dans ce pays; et les moeurs et coutumes des différens peuples sauvages qui l'habitent. Paris, 1743. 250 p. 3 maps. 16 pls. 12°. Pre-Linn. 1743.1

Bartholinus, *Caspar* [*Secundus, Thomæ filius*] [1655–1738] De respiratione animalium disputatio. Hafniæ, 1700. 12 p. 4°. Pre-Linn. 1700.1

—— De glossopetris dissertatio. Hafniæ, 1704. 10 p. 4°. Pre-Linn. 1704.1

—— The same, 2. ed. Hafniæ,, 1706. 12° Pre-Linn. 1706.1

Bartholinus, *Caspar* [1585–1629] Institutiones anatomicæ. Albi, 1611. 8°. Pre-Linn. 1611.1

Reprinted: Wittenberg, 1611; Rostock, 1622, 1626; Strasburg, 1622; Goslar, 1632.

—— The same. 2nd ed. Revised by Thomas Bartholin. Leyden, 1641. Pre-Linn. 1641.1

Often reissued: Leyden, 5 issues, 1645–1686; The Hague, 5 issues, 1655–1666; others (French), Paris & Lyons, 1647–1684. An English version is:

—— Bartholinus anatomy; made with the precepts of his father, and from the observations of all modern anatomists. Published by Nich. Culpeper, and A. Cole, Doctor of Physick. London, 1668. 153 figs. fol. Pre-Linn. 1668.1

—— (*præses*) Dissertatio tetras quæstionum physicarum. Lipsiæ, 1647. 2 pls. 4°. Pre-Linn. 1647.1

Bartholomæus, *respond.*

Question 3 discusses the respiration of fishes.

Bartholinus, *Thomas* [1616–1680] For a sketch of his life and a short analysis of his work, *see* Choulant, L. "Graphische Incunabeln für Naturgeschichte und Medicin. Bibliographie der Drucke des XVten und XVIten Jahrhunderts." Leipzig, 1858. 8°.

—— De unicornu observationes novæ. Patavii, 1641. 8°. Pre-Linn. 1641.1

Deals with all unicorn (one horned) animals; "piscis monoceros" among them.

—— De luce animalium, libri III. Leyden, 1643. Pre-Linn. 1643.1

Other editions are: Leyden, 1647; Copenhagen, 1669, & 1693.

—— De unicornu observationes novæ. Accesserunt de aureo cornus —— O. Wormii. Patavii, 1645. 304 p. illust. 8°. Pre-Linn. 1645.1

—— Historiarum anatomicarum et medicarum IV centuriæ. 5 vols. Copenhagen, 1654–1661. 4°. Pre-Linn. 1654.1

i. De pisce Illetif. Cent. I, ep. 24, 107.
ii. Anatome Xiphiæ. Cent. II, hist. 16, 196.

iii. Orbis piscis anatome [Tetrodon, Mola] Cent. II, hist. 1, 169.
iv. Piscis figura crucis signatus (passer piscis). Cent. II, hist. 33, 225.
v. Orbes maiores marini [Tetrodon, Mola] Cent. IV, hist. 34, 304.

—— De unicornu observationes novæ. Secunda editione auctiores emendatiores editæ a filio C. Bartolino. Amstelodami, 1678. xix, 381, 15, 40 p. illust. 12°. Pre-Linn. 1678.1

Titles reading "unicorn" not seen, and entered doubtfully. However, Bartholin wrote about both the mammal [Narwhal] and the fish [Xiphias].

Bartholomæus, —— (*respond.*) Dissertatio tetras quæstionum physicarum. Lipsiæ, 1647. 2 pls. 4°.

Casp. Bartholinus, *præses.*
Question 3 discusses the respiration of fishes.

Bartholomæus Anglicus [*fl.* 1230–1250] (Erroneously called Bartholomew de Glanville) For an analysis of his work and for brief data about the author, *see* Choulant, Ludwig. "Graphische Incunabeln der Naturgeschichte und Medecin . . . des XV und XVI Jahrhunderts." Leipzig, 1858. For critical data as to the dates of publication, *see* Sotheby, S. Leigh. "Principia typographica." 1858, **3**, 89–104; Duff, E. G. "Wm. Caxton," Chicago, 1905, and "XV century English books," 1917; and Voigt, E. "Englische Studien," 1910, **41**, 347. For an epitome in present-day English, *see* Steele, R. 1893.1.

—— De proprietatibus rerum. Coloniæ et Basiliæ, [1470]. 238 leaves. fol. Pre-Linn. 1470.1

This famous compilation, the first edition of which is listed above, is the first encyclopædia ever printed. Before the invention of printing many MS. copies had been made, of which specimens are to be found in the libraries of the B. M., Paris (MS. dated 1376), the Vatican, Oxford and Cambridge Universities, and elsewhere. First printed in 1470, 1471, or 1472 at Cologne, and at Basel 1472, it sprang into great favor. Besides a number of undated versions, at least 26 editions, mostly in folio, were issued 1470–1495; 10 during the 15th century, and 3 from 1601–1619 — the date of the last edition ever published. These are distributed as follows: Cologne, 4, 1470–1483; Basle, 1, 1470; London, 4, 1471–1582; Lyons, 5, 1482–1500; Strasburg, 6, 1480–1505; Nuremberg, 5, 1483–1519; Harlem 3, 1484–1495; Toledo, 2, 1494 & 1529; Paris, 2, 1556 & 1573; Venice, 2, 1516, 1571; Frankfort, 3, 1601–1619, — and French and Dutch editions of 1472 and 1479 without place. For the above we have records; there are probably others still not listed.

Early foreign versions, including English, are:

—— Cy commence ung tres excellent livre nommé le propriétaire des choses; cestuy livre fut translaté de Latin en François Frère Jean Corbichon [en 1372], et a este revisité par Frère Pierre Ferget. Lyon, 1482. gr. fol. Pre-Linn. 1482.1

—— Le propriétaire des choses. Lyon, 1485. fol. Pre-Linn. 1485.1

—— Van den proprietiejten der dingen. Haarlem, 1485. fol. Pre-Linn. 1485.2

The earliest Dutch ed. was, however, 1479.

—— All the proprytees of thynges [John Trevisa translator] Westmestre, Wynkyn de Worde, 1494 [or 1495] fol. Pre-Linn. 1494.1

The first English edition, and the first printed encyclopedia in the English language.

—— De los propriedades de las cosas. Toulouse [Tolosa ?], 1494. fol. Pre-Linn. 1494.2

—— De proprietatibus rerum [Thomas Berthelet]. London, 1535. fol. Pre-Linn. 1535.1

—— Batman uppon Bartholome, his book de proprietatibus rerum, newly corrected, enlarged and amended, etc. London, 1582. fol. Pre-Linn. 1582.1

Batman was the Rev. Dr. Stephen Bateman, Chaplain to Bishop Parker. The edition is a reissue of Wynkyn de Worde's 1494 version.

At the close of this volume is the following note: "Barthelmew Glanvyle, a Franciscan Frier, wrote this worke in Edward the Third's time, about the yeare of our Lord 1366 (1360 ?) — In the yeare 1397, 37 yeares after, was this sayd worke translated into English, and so remained by written coppie untill A. D. 1471, at which time printing began first in England, the 37 yeare of the Reign of King Henrie the 6; sithence this learned and profitable worke was printed by Thomas Berthelet, [London] 1535."

Copies of early editions are in H., Y., L. C., U. S. C., N. Y. P., J. C., & H. E. H.

Basilius Magnus (*Saint*) (*Basil the Great, Archbishop of Cæsarea in Cappadocia*). [329–379] Hexameron (in Opera [Greek]) Basiliæ, 1551. fol. Pre-Linn. 1551.1

Fishes in Homily vii, § 5.

The above is the *editio princeps.* Other eds. of his works are: Basel, 1552, 1565; Leipsic, 1566; Ingoldstadt (Dutch), 1591; Paris, (Greek & Latin, 2 vols.), 1618. fol.; Paris & Basel, 1654.

Found also in:

—— Librorum LX. Ecloga sive synopsis, hactenus desiderata. [Greek & Latin]. Basiliæ, 1575. Pre-Linn. 1575.1

An English translation of the "Hexameron" by Rev. Blomfield Jackson is contained in the "Select lives of Nicene and post-Nicene fathers." 2. ser. New York, 1895.

Bassus, *Cassianus* [*fl.* 6*th.* & 7*th. cents.* A.D.] Geoponica. De re rustica selectorum libri xx. Græci Constantino quidem Cæsari nuncupati . . . J. A. Brassicani opera in lucem editi . . . Item, Aristotelis de plantis libri duo Græci . . . hac primum editione restituti (S. Grynæi Præfatio). Basileæ, 1539. xlvii, 551 p. 8°. Pre-Linn. 1539.1

Attributed in some editions to Constantine IV, and in others to Constantine VII, Emperors of Constantinople, but now known to have been compiled by Bassus and to have been revised by an unknown editor and published (in MS.) about 950.

The 2nd ed. The first (in Greek) Basel, 1538. Other Latin eds. (at least 3), Venice, Basel, & Leyden (one in 1541); in Italian, Venice, 1542 & 1549; French, Poictiers, 1543.

—— Der Feldbaw, oder das Buch von der Feldarbeyt. Vor tausent Jahren von dem . . . Keyser Constantino IIII inn Griechischer Sprach beschriben, unnd durch D. M. Herren verdolmetscht. Jetzund von newem widerumb uberlesen, gemehret und bebessert [with a preface by L. Rabus von Memmingen]. Strassburg, 1551. ccxxvii, 24 p. 8°. Pre-Linn. 1551.1

—— Geoponika. Geoponicorum, sive de re rustica, libri xx. Cassiano Basso scholastico collectore. Antea Constantino Porphyrogenneto a quibusdam adscripto. Græce et Latine. Cantabrigiæ et Londonis, 1704. 8°. Pre-Linn. 1704.1

Another and excellent edition, edited by J. J. Niclas, was published at Leipsic, 1781. A late English version by T. Owen was issued at London, 1805, under the title "Geoponica. Agricultural pursuits." For other modern editions, *see* Encyclopædia Britannica, 1910, vol. III.

The "Geoponica" is a compilation from the writings of various Roman writers on farming. The 20th book, consisting of 46 short chapters is devoted to fish and fishing.

Baulacre, ——. Oeuvres. Band I. Genève, 1738–1756. Pre-Linn. 1738.1

Swiss fishes are considered.

Bayle, *Francis* [1622–1709] Dissertationes [Problematæ] physicæ, in quibus principia proprietatum in mixtus, oeconomia corporum in plantis et animalibus demonstrantur. Tolosæ, 1677. Pre-Linn. 1677.1

Remora as a ship-holder; relative amounts of muscle and bone in fish, etc.

Other eds.: Toulouse, 1681 & 1701; The Hague, 1678.

Beal, *John* [1603–1683] [Account of shining fish] Phil. Trans. Roy. Soc. London, 1666, **1**, 226–228. Pre-Linn. 1666.1

First known account of putrefaction causing phosphorescence.

—— On the effect of frost on eels. Phil. Trans. Roy. Soc. London, 1666, **1**, 323. Pre-Linn. 1666.2

Beckmann, *J. V.* (*præses*) Disputatio de jure piscandi. Inaug. Dissert. Jenæ, 1676. 4 pls. 4°. Pre-Linn. 1676.1

J. Volckhart, *respond.*

Beenius, *Johannes* (*præses*) Piscis ille grandissimus, qui Jonam integrum devoravit. Hafniæ, 1698. 4°. Pre-Linn. 1698.1

Sever. Arctander, *respond.*

Beermann, *Sigism.* Epistola in qua van der Hardt Jonas in Carcharia examinatur. Wolfenbüttel, 1719. 8°. Pre-Linn. 1719.1

Belon, *Pierre* [1517–1564] For a short sketch and account of his work, *see* Miall, L. C., 1912.1. For a larger biography with a full bibliography, *see* Morren, Edouard. "A la mémoire du Pierre Belon du Mans, 1517–1564." Belgique Horticole, 1885, **35**, 1–29. portr.

—— L'histoire naturelle des estranges poissons marins, avec la vraie peincture et description du dauphin et de plusieurs autres de son espèce, observées par Pierre Belon du Mans. Paris, 1551. 55 p. index. figs. 4°. Pre-Linn. 1551.1

Other eds.: Paris, 1553 & 1555.

—— De aquatilibus libri duo. Cum eiconibus ad vivam ipsorum effigiem, quoad eius fieri potuit, expressis. Parisiis, 1553. 16 leaves. 448 p. obl. 8°. Pre-Linn. 1553.1

110 fishes are named and described.
2nd ed., 1620. fol.

—— Les observations de plusieurs singularitez et choses mémorables, trouvées en Grèce, Asie, Indée, Egypte, Arabie & autres pays estranges, redigées en trois livres, par Pierre Belon du Mans Paris, 1553. 211 p. 4°. Pre-Linn. 1553.2

The first ed. A second, revised and augmented, Paris, 1554. Others: Paris, 1555, 1558, 1585, 1588; Antwerp, 1555, 1558, 1589, 1605. The last ed. is dated 1620. Found also in Ray, J. "A collection of travels and voyages," etc. 1693.

Some fishes are mentioned, as for instance the parrot-wrasse, Scarus, which Aristotle had declared to be the only fish that ruminates. Accounts are given also of fishing by the peoples visited.

—— La nature et diversité des poissons, avec leurs pourtraicts, representez au plus près du naturel. Paris, 1555. 448 p. illust. 12°. Pre-Linn. 1555.1

This is a translation into French of the "De aquatilibus," etc. Another edition, Paris, 1560.

—— Portraits d'oyseaux, animaux, serpens, herbes, arbres, hommes et femmes, d'Arabie & Egypte, observez par P. Belon du Mans. Paris, 1557. 242 p. 220 woodcuts & maps. 4°. Pre-Linn. 1557.1

Another edition, 1618.

—— Plurimarum singularium et memorabilium rerum in Græcia, Asia, Aegypte, Judea, Arabia, aliisque exteris provinciis ab ipso conspectarum observationes tribus libris expresiæ. Raphelengii, 1605. 242 p. fol. Pre-Linn. 1605.1

Translated from the French and edited by Carolus Clusius. Fish and fishing, pp. 15, 35, 71–73, 100.

Berkel, *Adrian van.* Amerikaansche voyagien, behelzende een reis na Rio de Berbice, gelegen op het vaste land van Guiana, . . . mitsg. een andere na de colonie van Suriname enz. . . . Amsterdam, 1693, viii, 139 p. pls. 4°. Pre-Linn. 1693.1

Contains the first known description of *Gymnotus electricus.*

Berners, *Juliana.* *See* **Barnes,** *Juliana.*

Bernes, *Juliana.* *See* **Barnes,** *Juliana.*

Bernhardi, *Fab.* (*respond.*) Exercitatio physica de respiratione piscium, quam statuunt nonnulli. Jenæ, 1656. 4°. Pre-Linn. 1656.1

Melchior Zeidler, *præses.*

Besler, *Basil* [1561–1629] Rariora musei Besleriani quæ olim B. et M. R. Besleri collegerunt, æneisque tabulis ad vivum incisa evulgarunt: nunc commentariolo illustrata a J. H. Lochnero &c. Norimbergæ, 1716. xiv, 112 p. 41 pls. fol. Pre-Linn. 1716.1

Fishes, pp. 55–68. Fossil fishes, p. 93–94. Glossopetras, p. 105. All with figures.
The contents of this Museum were collected and were figured on copper by B. and M. R. Besler and the descriptive text written by J. H. Lochner von Hummelstein. *See* also Besler, M. R., & Lochner von Hummelstein, J. H. Copy, A. M. N. H.

Besler, *Michel Rupert* [1607–1661] Gazophylacium rerum naturalium, e regno vegetabili, animali & minerali depromptarum, nunquam hactenus in lucem editarum, fidelis cum figuris æneis ad vivum incisis repræsentatio. Opera Michælis Ruperti Besleri Medici. Leipsic, 1642. pls. fol. Pre-Linn. 1642.1

Other eds.: Leipsic & Frankfort, 1716 & 1733.
A rare work containing copper plates of fishes, birds and mollusks, without text.

—— Rariora musei Besleriani quæ olim Basilus et Mich. Rup. Besler collegerunt æneisque tabulis ad vivum incisa evulgarunt: nunc commentariolo illustrata a Joh. Henr. Lochnero, denuo luci publicæ commisit . . . Mich. Frid. Lochner. Norimbergæ, 1716. 22 & 112 p. 40 pls. fol. Pre-Linn. 1716.1

Seven fishes are figured and described, p. 55–68. Fossil fishes, p. 93–94. Glossopetras, p. 105.
See also Besler, B., & Lochner von Hummelstein, J. H.

Bianchi, *Giovanni* [1693–1775], pseudonym for **Plancus,** *Janus.*

Bingen, *Hildegarde* (*Abbess of*) *See* **Hildegarde de Pinguia.**

Binnell, *Robert.* Description of the river Thames . . . with the City of London's jurisdiction and conservancy thereof . . . to which is added a brief description of those fish, with their seasons, spawning times, etc., that are caught in the Thames, or sold in London. With some few observations on the nature . . . peculiar to fish in general, etc. London, 1758. 8°. Pre-Linn. 1758.1

See Griffith's "An essay to prove, etc.," 1746, of which this is a plagiarized copy. *See* also Binnell, R. 1785.1.

Birch, *Thomas* (*editor*) [1705–1766] History of the Royal Society in London. 4 vols. London, 1756–57. 4°. Pre-Linn. 1756.1

In the form of printed minutes, an account is given of the proceedings with short abstracts of papers read.

Birckerodius, *Thomas Broderus.* Sciagraphia . . . sive de cornibus et cornutis commentariorum, quos ex omni antiquitate, scientia et arte collectos, sex libris distinctos . . . quadrupedum, piscium . . . aliarum rerum, ultra mille, illustratos publico destinavit, et brevi, volente Deo, legendos dabit. Hafniæ, [*ante* 1694]. 28 p. 4°. Pre-Linn. 1694.1

Blacuod, *Henr.,* & **Debonnaire,** *Jo.* Ergo pisces febricitantibus carnibus salubriores. Paris, 1587. Pre-Linn. 1587.1

Title from Boehmer.

Blagrave, *Jos.* [1610–1682] The epitome of the art of husbandry. Comprising . . . directions for the use of the angle, etc. London, 1669. 12°. Pre-Linn. 1669.1

Other eds.: London, 1675; 1685; 1719.
In the 1685 ed., fishes and fishing cover 19 pages.

Blasius, *Gerard* [*c.* 1623–1682] Observationes anatomicæ selectiores, editæ e collegio medicorum privatorum Amstelodamensis. Amsterdam, 1667. 12°. Pre-Linn. 1667.1

Contains observations on the viscera of fishes.
A later ed. is:

—— Observationum anatomicarum collegii privati Amstelodamensis, pars altera, in quibus præcipue de piscium pancreate ejusque succo agitur. Amsterdam, 1673. 12°. Pre-Linn. 1673.1

—— Anatome animalium, terrestrium variorum, volatilium, aquatilium, serpentum, insectorum, ovorumque, structuram naturalem ex veterum, recentiorum, propriisque observationibus proponens, figuris variis illustrata. Amstelodami, 1681. 494 p. 60 pl. 4°. Pre-Linn. 1681.1

One of the earliest books on comparative anatomy. The internal structure of a considerable number of fishes is taken up in some detail, p. 259–308, and in 6 plates. Copy, N. Y. P.

Blégny, *Nic. de* [1652–1722] De pisce remora. Zodiacus-medico-gallicus, 1682, an. iv, 92. Pre-Linn. 1682.1

Blome, *Richard* [–1705] The gentleman's recreation. In two parts; the first being an encyclopedy of the arts and sciences . . . the second part treats of horsemanship, . . . fishing and agriculture, etc. London, 1686. fol. Pre-Linn. 1686.1

Another ed. appeared in 1710 in folio.

—— Present state of his majesties isles and territories in America. London, 1687. Pre-Linn. 1687.1

Fisheries, pp. 20, 38, 79, 118, 135, 165, 189, 239, 250–252. French translation, Amsterdam, 1688; German, Leipzig, 1697.

Bluntschli, ——. Memorabilia Tigurina. Merkwürdigkeiten der Stadt und Landschaft Zürich 1742. Zürich, 1742. 713 p. 4°. Pre-Linn. 1742.1

Contains data on fishes of Zurich.

Boccone, *Paulo* afterwards *Sylvio* [1633–1704] Recherches et observations naturelles touchants le corail . . . les dents de poissons petrifiées . . . la sangsue du Xiphias, etc. Paris, 1670. 16 pls. 12°. Pre-Linn. 1670.1

Other eds.; (French) Amsterdam, 1671, 1672, 1674; (Italian) Bologna, 1684; (German) Frankfort, Leipzig, & Jena, 1697; (Dutch) Amsterdam, 1744 or 1745.

—— Recherches et observations naturelles sur la production de plusieurs pierres, sur la pétrification de quelques parties d'animaux, sur les principes des glossopètres, sur la pierre étoilée et sur l'embrasement du Mont Etna. Paris, 1671. 12°. Pre-Linn. 1671.1

—— [A not ordinary sangui-suga or leech, found sticking fast in the Xiphias or sword-fish]. Phil. Trans. Roy. Soc., 1673, **8**, 6159–6160. Pre-Linn. 1673.1

—— Museo di fisica, e di esperienze variato e decorato di osservazioni naturali, . . . Con una dissertazione dell' origine e della prima impressione delle produzioni marine, etc. Venezia, 1697. viii, 319 p. 18 pls. 4°. Pre-Linn. 1697.1

"De Glossopetris, p. 179; de Lavareto & Salione piscibus rarioribus, p. 289."

—— Descriptio anatomica *Canis carchariæ.* (In Valentini, M. B. Amphitheatrum Zootomicum, Francofurti, 1720, pt. 2, p. 120–121. pl. 70) Pre-Linn. 1720.1

Reprinted from "Recherches et observations naturelles," p. 327. First figure of teeth tiger shark.

—— Natuurkundige naspeuringen op proef- en waarnemingen gegrond. Zynde behalven een uitvoerige navorssing . . . van de oorzaak der wonderbare versteningen van verscheide lighamen. 's Gravenhage, 1745. pls. 8°. Pre-Linn. 1745.1

A Dutch version of 1697.1

Bocer, *Henricus* (*præses*) Disputatio de domino proprietatis et ejus acquirendi modus . . . et quidem de venatione, piscatione et inventione. Inaug. Dissert. Tubingiæ, 1599. 4°. Pre-Linn. 1599.1

Casper Henchelin, *respond.*

Bochart, *Samuel* [1599–1667] Hierozoicon seu de animalibus S. Scripturæ compendium in duas partes divisum quarum prior IV libris animalia in genere, quadrupedes domesticas, feras & oviparis. Posterior VI libris aves mundas, immundas, serpentes, insecta, aquatica, fabulosa animalis pandit a Stephano M. Vecseo adornatum. Franequeræ [Franeker], 1619. 4°. Pre-Linn. 1619.1

Second and enlarged ed. is:

—— Hierozoicon seu de animalibus S. Scripturæ opus bipartitum, cujus pars prior libris IV de animalibus in genere, & de quadrupedibus viviparis & oviparis: pars posterior libris VI de avibus, serpentibus, insectis, aquaticis & fabulosis animalibus agit. 2 vols. Londini, 1633. fol. Pre-Linn. 1633.1

Other eds. of this very learned work are: London, 1663; Frankfort, 1667 & 1675; Franeker, 1690; Leyden & Utrecht, 1712; Leipsic, 1793–96 (3 vols.).

—— Opera. Lugduni Batavorum & Ultrajecti, 1692. fol. Pre-Linn. 1692.1

Other eds.: Leyden, 1722; Leipsic, 1799.
In the 1793–96 issue (edited by E. F. C. Rosenmüller), vol. III, chap. XII contains Jonah's whale (argued to be a Carcharias shark); chap. XIII, the Zygæna shark; chap. XIV, the Tobias fish.

Bock, *Hieronymus* (vulgo *Tragus*) [1498–1554] New Kreutter Buch, von Underscheydt, Würckung und Namen der Kreutter, so in teutschen Lande wachssen. Auch derselbigen eygentlichen und wolgegründen Gebrauch in Arzney &c. 2 vols. [in 1]. Strassburg, 1539. vi, 174; 88, iv p. fol. Pre-Linn. 1539.1

Other eds.: Strassburg, 1551, 1556, 1557 — all folio. A later ed.:

—— Von den vier Elementen, zamen und wilden Thieren, auch Vögeln, Fischen, und allerhandt Gewürz. (In his Herbarium. Argentorati, 1577, pt. IV, 397–350. fol.) Pre-Linn. 1577.1

—— Kreütterbuch, darin Underscheidt, Nammen, und Würckung der Kreütter, . . . Item von den vier Elementen, zamen und wilden Thieren, auch Vögeln, und Fischen, &c. &c. Strassburg (1587?). liv, 454, 46 p. ills. fol. Pre-Linn. 1587.1

Edited and augmented by Melchior Sebizium. A still later edition, Strassburg, 1630.

Bodin, *Jean* [1530–1596] Commentarius in Oppianum de piscium natura & venatione. Lutetiæ, 1555. 4°. Pre-Linn. 1555.1

—— Universæ naturæ theatrum in quo rerum omnium effectrices causæ et fines contemplantur et discutiuntur. Lugduni, 1596. 8°. Pre-Linn. 1596.1

—— Le théâtre de la nature universelle. Lyon, 1597. 8°. Pre-Linn. 1597.1

Natural history and habits of fishes, pp. 460–480.
Other eds.: Frankfort, 1597 & Hannover, 1605.
Copies, 1597 eds., Col.

Böckler, *G. A.* Nützliche Haus- und Feldschule. Wie man ein Land- und Feld-Guth und Meyery mit aller Zugehöre mit Nützen anordnen solle. 2 parts. Frankfurt, 1669. pls. 4°. Pre-Linn. 1669.1

Bol, *J.* Venationis, piscationis et aucupii typi. *c.* 1600. obl. 4°. Pre-Linn. 1600.1

"Contains 43 plates engraved by Philip Galle from the celebrated paintings by J. Bol, representing hunting, fishing, shooting, falconry, etc." W. & S. Copy, N. Y. P.

Bonanni, *Filippo*. *See* **Buonanni,** *F.*

Bonge, *Dan.* (*respond.*) Dissertatio de salmonum naturâ, eorumque apud Ostrobothnienses piscatione. Upsala, 1730. 27 p. fig. 4°. Pre-Linn. 1730.1

Laurence Roberg, *præses*.

Bontius *or* **Bondt,** *Jac.* [*Jan*] [1599–1631] De medicina Indorum libri IV, etc. Lugduni Batavorum, 1642. 212 p. Pre-Linn. 1642.1

11 fishes described.
Appended to W. Piso's "De Indiæ utriusque re naturali et medica, etc.," 1658, under the title:

—— Historiæ naturalis et medicæ Indiæ orientalis libri VI. Amstelædami, 1658. Pre-Linn. 1658.1

Also reprinted under original title in Alpinus, P., "Medicina Aegyptorum, etc." 1718 & 1745. An English version is:

Account of the diseases, natural history, and medicines of the East Indies. London, 1769. 8°.
This contains no descriptions of fishes but treats of fish as food, p. 122–127.

Bondt was the first author to describe fishes from Batavia, in which city he lived and practiced medicine.

Bontius, *Jac.*, **Piso,** *Gul.*, & **Markgraef,** *Geo.* Oost- en West-Indische warande, vervattende aldaar de leef- en geneeskonst. Met een verhaal van de specerijen, boom- en aardgewassen, dieren etc. in O. en W. L. voorvallende. Amsterdam, 1694. viii, 304, viii, 96 p. 8°. Pre-Linn. 1694.1

Bontius on the use of fish as food and medicine, p. 14–20. Nothing by either Piso or Marcgraef, who are little referred to.
Copy, N. Y. A. M. 2nd ed., Amsterdam, 1734.

Boodt, *Anselm Boethius de* [1550–1634] Gemmarum et lapidum historia. Hanoviæ, 1609. figs. 4°. Pre-Linn. 1609.1

Glossopetras, liber IV, p. 301 & 343.
Other eds.: Bruges, 1609; Lugduni Batavorum (edited by A. Tollius) 1636 & 1647; Lyon, 1644. A French ed. is entitled:

—— Le parfaict joaillier ou histoire des pierreries [annotated by André Toll] Lyon, 1649. ills. Pre-Linn. 1649.1

De la Glossopetra, etc., p. 435–437.
Copy, N. Y. P.

Bordone, *Benedetto*. Isolario. 1527. Pre-Linn. 1527.1

Some West Indian fishes are mentioned.
See also Santa Cruz, "El yslario general de todas las yslas del mundo," written *c*. 1544, and edited by Franz R. von Wiesel, in his "Karten von Amerika." Innsbruck, 1908.

—— Libro di Benedetto Bordone nel qual si ragiona de tutte l'isole del mondo con li lor nomi antichi & moderni, historie, favole, & modi del loro vivere, & in qual parte del mare stanno, & in qual parallelo & clima giacciono. Venice, 1528. 83 leaves. Pre-Linn. 1528.1

Other eds.: Venice, 1534, 1537, 1547. These & 1528 ed. in J. C. B.

Borelli, *Giovanni Alphonso* [1608–1679] Philosophia de motu animalium ex principio mechanico-statico. 2 vols. Romæ, 1680–1682. 168 p. figs. 4°. Pre-Linn. 1680.1

Borelli studied the mechanism of swimming and determined the function of the swim bladder.
Other eds. are: Leyden, 1685, 1710, 1711; Naples, 1734; The Hague, 1742 & 1743. The full title of the latter is:

—— De motu animalium. Edit. nova, ac dissertationibus physico-mech. de motu musculosum etc. J. Bernoully aucta et ornata. 2 parts. Hagæ, 1743, 222, 18 & x, 270, 14 p. 20 pls. Pre-Linn. 1743.1

Borrich, *Olaus* [1626 *or* 27–1690] De aci marini anatome [*Belone vulgaris*] Acta. Med. Phil. Hafnien. (Bartholini), 1673 (1675), **2**, 149–151. Pre-Linn. 1675.1

Reprinted in Valentini, M. B. "Amphitheatrum Zootomicum." 1720, pt. 2, p. 119.
Original not seen. Agassiz assigns this title to Jacobæus, O. (Pre-Linn. 1675.1); Carus & Engelmann, to Borrich, O; while both Walbaum & Gronovius list it under both authors.

Bosman, *Willem*. Nauwkeurige beschryving van de Guinese Goud-Tand- en Slave-kust, etc. 2 vols. [in 1] Trajecti, 1704. xxvi, 208, 280 p. illust. 4°. Pre-Linn. 1704.1

Other eds.: Dutch, Amsterdam, 1709, 1718, & 1737; Italian, Venice, 1752–54. Titles of known foreign versions follow.

—— A new description of the coast of Guinea . . . written originally in Dutch . . . and now faithfully done into English, etc. London, 1705. viii, 493 p. 7 pls. map. 8°. Pre-Linn. 1705.1

A second English ed. was issued in 1721. Bosman's work is also reprinted in Pinkerton's "Collection of voyages." 1814, vol. XVI.

—— Voyage en Guinée, contenant une description de cette côte, des animaux, des oiseaux, des poissons, etc. Utrecht, 1705. pls. 8°. Pre-Linn. 1705.2

—— Reyse nach Guinea, etc. Hamburg, 1708. xii, 590 p. 4 pls. Pre-Linn. 1708.1

Bossche, *Gulielmus van den*. Historia medica, in qua libris IV animalium natura et eorum medica utilitas exacte et luculenter tractantur. Bruxellæ, 1639. xiv, 434, 20 p. ills. 4°. Pre-Linn. 1639.1

Fishes, p. 319–386.

Bossman, *Wilhelm*. *See* **Bosman,** *Willem*.

Bossow, *P*. Quæstiones juris de venatione, aucupio et piscatione. Basle, 1618. 4°. Pre-Linn. 1618.1

Boucher, *P*. Histoire véritable et naturelle des moeurs et productions du pays de la Nouvelle France; vulgairement dite le Canada. Paris, 1664. xxiv, 168 p. ills. 12°. Pre-Linn. 1664.1

Names are given of the fishes which are found in the St. Lawrence, and in the lakes and rivers tributary to it.

Boussuet, *Franciscus* [1520–1572] De natura aquatilium carmen in universam Gulielmi Rondeletii, quam de piscibus marinis scripsit historiam; cum vivis eorum imaginibus. Opusculum nunc primum in luce emissum. Lugduni, Gallorum, 1558. 240 p. ills. 4°. Pre-Linn. 1558.1

—— De natura aquatilium carmen, in alteram partem G. Rondeletii de aquatilibus historiae. Lugduni, 1558, 135 p. ills. 4°. Pre-Linn. 1558.2

These rare works form a pictorial history of fishes. Rondelet's figures are used and each has beneath it a short Latin verse in epigrammatic form describing the fish. They are generally bound together, but each has its own title page and separate pagination.

Bowlker, *Richard.* The art of angling, improved in all its parts, especially fly-fishing. Worcester, (1746?). 12°. Pre-Linn. 1746.1

This famous work, revised by the author's son, Charles, passed through a large number of eds. In the Heckscher sale catalogue, 1909, 12 issues are listed; 1758–1854.
See also Bowlker, R., 1758.1.

Boyle, *Robert* [1627–1691] For a sketch of his life by Thomas Birch, *see* edition of works below, 1744.

—— New experiments concerning the relation between light and air (in shining wood and fish), etc. Phil. Trans. Roy. Soc. London, 1667, **2**, 591–600. Pre-Linn. 1667.1

Phosphorescence of dead fish in a vacuum.

—— Of the motion of the separated heart of a cold animal [Anguilla] in the exhausted receiver. Phil. Trans. Roy. Soc. London, 1670, **5**, 2027–2028. Pre-Linn. 1670.1

—— Of the phænomena of a scale-fish in an exhausted receiver. Phil. Trans. Roy. Soc. London, 1670, **5**, 2024–2026. Pre-Linn. 1670.2

—— Philosophical works abridged, methodized and disposed under the general heads of physics, statics, pneumatics, natural history, &c. 3 vols. London, 1725. figs. 4°. Pre-Linn. 1725.1

Other eds.; 1738, 1744 (with the life of Boyle by Thomas Birch), & 1772.

Boyle, *Roger* [*c.* 1621–1679] Occasional reflections upon several subjects, whereto is premis'd a discourse about such kind of thoughts. London, 1665. 12°. Pre-Linn. 1665.1

Contains data about fish and fishing.
2nd ed., 1669. Reprinted, London, 1808; Oxford, 1848.
Attributed by Westwood & Satchell to Hon. Robert Boyle. Copy in N. Y. P. written by Roger Boyle [1st Earl of Orrery ?]

Braccio, *Ignacio.* Remoræ pisciculi effiges. Romæ, 1634. 1 p. fig. fol. Pre-Linn. 1634.1

No copy of this work, consisting of one page with woodcut, seems extant. There was formerly a copy in the British Museum, a part of the Sir Hans Sloane collection, but it has been lost.

Bradley, *Richard* [–1732] A philosophical account of the works of nature, etc. London, 1721. xx, 194 p. 28 pls. 4°. Pre-Linn. 1721.1

Fish ponds and breeding of fish are treated of, p. 178–181.
A 2nd ed.: London, 1739.

—— The country gentleman and farmer's monthly director . . . Wherein is directed the . . . breeding and feeding of . . . fish, swine, and all sorts of cattle. London, 1726. 8°. Pre-Linn. 1726.1

—— Wysgeerige verhandeling van de werken der natuure. Amsterdam, 1744. 31 pls. 8°. Pre-Linn. 1744.1

Brander, *Fredrik Reinhold* (*respond.*) Dissertatio de regiâ piscaturâ Cumoensi. Inaug. Dissert. Aboæ, 1751. 48 p. 2 pls. 4°. Pre-Linn. 1751.1

Carl Fred. Menander, *præses.*
For other works on husbandry by this author, *see* Catalogue British Museum (Natural History). All these presumably have chapters dealing with fish ponds and fish culture.

Brassicanus, *Johannes Alexander.* [1500–1539] De re rustica selectorum libri xx Græci . . . J. A. Brassicani opera in lucem editi, &c. 1539. 8°. Pre-Linn. 1539.1

See also Bassus, C., Pre-Linn. 1539.1.

Brauner, *Johann.* Beschreibung der Fischer-Zäune und ihres Gebrauchs. König. Schwed. Akad. Abhandl., 1753, **15**, 277. Pre-Linn. 1753.1

See note under Kästner, A. G., Pre-Linn.

—— Beskrifning pä fiske-katsor och deras nyttiande. K. Swensk. Vetensk. Acad. Handl., 1753, **14**, 272. Pre-Linn. 1753.2

Breton, *Nicholas* [*c.* 1545–1627] Wit's-Trenchmour; in a conference had between a scholler and an angler. London, 1597. sm. 4°. Pre-Linn. 1597.1

This is said to have furnished the idea of Walton's "Angler."

Breton, *Raymond* [1609–1679] Dictionnaire Caraibe-François. Auxerre, 1665. Pre-Linn. 1665.1

Contains Carib names for fishes and other natural history objects.
Facsimile reprint by Jules Platzmann, Leipzig, 1892.

Brickell, *John.* The natural history of North Carolina . . . Illustrated with copper plates, whereon are curiously engraved the map of the country, several strange beasts, birds, fishes, snakes, insects, trees, and plants, etc. Dublin, 1737. 408 p. woodcuts, pls. map. 8°. Pre-Linn. 1737.1

Of the fish of North Carolina, pp. 215–249.
2nd ed.: Dublin, 1743.

Bring, *Sven.* (*præses*) Dissertatio de piscaturis in Oceano Boreali.

Bring, *S.* Londini Gothorum [Lund], 1750. 29 p. 4°. Pre-Linn. 1750.1

Carl Estenberg, *respond.*

Brisson, *Mathurin Jacques* [1723–1806] Système naturel du règne animal, par classes, familles ou ordres, genres et espèces, avec une notice de tous les animaux etc. suivant la méthode de Klein; avec une notice de celle de Linnaeus, et l'ordre des poissons, suivant la division d'Artedi et l'ordre des oursins de mer. 3 vols. Paris, 1754. 10 pls. 8°. Pre-Linn. 1754.1

Not seen. Said to be a translation of a (to us unknown) work by J. T. Klein. Often confused with a similar work by La Chesnaye Desbois (1754.1, *q. v.*)

Brockelsby, *Richard* [1722–1797] Upon the sounds and hearing of fishes, by J. T. Klein, or some account of a treatise entitled "An inquiry into the reasons why the author of an epistle concerning the hearing of fishes endeavors to prove they are all mute and deaf." Phil. Trans. Roy. Soc., 1748 (1750), **45**, 233–239. Pre-Linn. 1750.1

Brodd, *Andrew.* (*respond.*) Ichthyologiæ biblicæ pars prima, de ave selav, cujus mentio fit num. XI: 31, in qua contra Bochartum & Ludolfum non avem aliquem plumosam, nec locustam fuisse, sed potium quoddam piscis genus (pisces volatiles) manifestis demonstratur argumentis. Upsaliæ, 1705. 148 p. figs. Pre-Linn. 1705.1

Olaus Rudbeck (junior), *præses.*

Brohon, *Joannes.* De stirpibus vel plantis ordine alphabetico digestis epitome . . . [2. ed.] per J. Brohon . . . edita. Cui accesserunt volatilium, gressilium, piscium . . . apud Gallias nominum, per Leodegarium a Querco. Parisiis, 1543. 65 p. 4°. Pre-Linn. 1543.1

First ed.: 1541.
This is based on a similar work by Leodegarius de Quercu (*q. v.*).

Bronzer, *Johann Hieronymus.* Disputatio de principatu hepatis ex anatome lampetræ. Patavia. 1626. 4 p. 4°. Pre-Linn. 1626.1

Brookes, *Richard* [*fl.* 1750] The art of angling, rock and sea-fishing, with the natural history of river, pond, and sea-fish. London, 1740. 133 figs. 12°. Pre-Linn. 1740.1

First ed.: 2nd, London, 1743. An enlarged ed. is:

The art of angling. New improved with additions, and formed into a dictionary. In two parts. I. Containing an account of fish and fish-ponds: a new art of fly-making: the new laws that concern angling: the secret ways of catching fish by ointments, pastes and other arts: directions how to procure baits, and for making all sorts of fish-tackle, with the surest method of finding sport, etc. London, 1766. viii, 292 p. 136 figs.
Many later eds., at least 15 up to 1811.

Brown, *Edward.* A brief account of some travels in Hungaria, Servia, Bulgaria, Macedonia, Thessaly, Austria, Styria, etc. London, 1673. 4°. Pre-Linn. 1673.1

Hungarian fishes, p. 10–12; fishes of the Danube, p. 109 110. figs.
Pagination in parts. Other eds.: London, 1677, 1685; French, Paris, 1674, 1684; Dutch, Amsterdam, 1682; German, Nürnberg, 1686, 1711, 1750.

Browne, *Patrick* [*c.* 1720–1790] The civil and natural history of Jamaica. In three parts. Containing . . . A history of the natural productions, including the various sorts of native fossils . . . London, 1756. viii, 503 p. 49 pls. map. Pre-Linn. 1756.1

The author, a physician of Jamaica, describes in this work 93 species of fishes, arranged after the Artedian system. His observations are regarded by Cuvier as much better than those of Sloane for the same fauna.
2nd ed.: London, 1789. fol. (*See* Browne, P., 1789.1)

Browne, *Peter* [*c.* 1665–1735] A letter from a clergy-man in Ireland; giving an account of the taking of great numbers of fish, and of many sea-monsters, in the county of Clare, in that kingdom . . . London, 1721. 42 p. 4°. Pre-Linn. 1721.1

Browne, (*Sir*) *Thomas* [1605–1682] For a notice of his work as a naturalist, *see* Nicholson, W. A. 1900.1.

—— Enquiries in the vulgar errors. London, 1646. fol. Pre-Linn. 1646.1

This curious and interesting book contains some data about fishes.
Other eds. are: London, 1650, 1658, 1664, 1666 (2 issues), 1672, 1686; Frankfort & Leipsic, 1668 (German); Paris, 1733 (French). A modern ed., London, 1852, in N. Y. P.

—— Certain miscellany tracts. 1684. vi, 215 p. 8°. Pre-Linn. 1684.1

Tracts iii and iv treat of fishes.
Many later editions have appeared.
For his notes on the fishes of Norfolk (not published until after 1758), *see* Browne, Sir T., 1835.1 & 1902.1.
A modern ed. of his works was issued Edinburgh, 1912, 3 vols. sm. 8°.

Brückmann, *Franz Ernst* [1697–1753] Specimen physicum exhibens historiam naturalem oolithi seu ovariorum piscium et concharum in saxa mutatorum. Helmstadt, 1721. 28 p. 4°. Pre-Linn. 1721.1

—— Observatio de lactibus et ovis in uno carpione. Comm. Lit., Norimberg, 1734, 177. Pre-Linn. 1734.1

—— De figura lapidum ex pisci quodam Indico, cum effigio St. Petri, St. Peterstein genannt. Comm. Lit., Norimberg, 1739, 209. fig. Pre-Linn. 1739.1

—— Von den Schlampeiskern oder Wetter-Fischen. Hamburg. Ber. Gelehrt. Sachen, 1741, 633. Pre-Linn. 1741.1

—— De glossopetris et chelidoniis (In his Centuria epistolarum itinerarium. Wolfenbüttelæ, 1742, 1. cent., epist. 29) Pre-Linn. 1742.1

—— De vermibus quibus Helgolandi ad piscatum hamatilem utuntur. Comm. Lit., Norimberg, 1742, 381. fig. Pre-Linn. 1742.2

—— Bibliotheca animalis oder Verzeichniss derer meisten Schriften, so von Thieren und deren Theilen handeln, was hievon sowohl Theologi, Icti, Medici, Historici, als auch Chymici, Physici und Jäger geschrieben, nach alphabetischer Ordnung. Wolfenbüttel, 1743. 277 p. 8°. Pre-Linn. 1743.1

—— Bibliotheca animalis continuatio. Wolfenbüttel, 1747. 8°. Pre-Linn. 1747.1

—— Petrefactum singulare dentem seu palatum piscis ostracionis referens. Act. Nat. Cur., Nürnberg, 1752, **9**, 116–120. Pre-Linn. 1752.1

Brückner, *Emil Daniel.* Versuch einer Beschreibung historischer und natürlicher Merkwürdigkeiten der Landschaft Basel. 5 vols. Basel, 1748–63. 3076 p. figs. 101 pls. 8°. Pre-Linn. 1748.1

Various notes on fishing, p. 554, 632, 648.

Bruckmann, *Fridericus.* Tractatus III de venatione, piscatione et aucupio. Spiræ, 1605. 4°. Pre-Linn. 1605.1

Westwood and Satchell, Artedi, and Boehmer write the name as above, but the former also list the same book under Prueckmannus, Fr.

Bruyn, *Cornelius* [1652–1719] Reizen door de vermaardste deelen van Klein Asia, de eylanden Scio, Rhodus, Cyprus enz. mitsg. de voornaamste steden van Aegypten, Syrien, en Palastina, etc. Delft, 1698. xx, 398 p. 210 pls. portr. fol. Pre-Linn. 1698.1

Various fishes are figured and described. Versions in French and English are:

—— Voyage au Levant. Delft, 1700. pls. fol. Pre-Linn. 1700.1

In another French ed. of the above (1714), there is in chap. LVIII, p. 309, a description of fossil fishes found at Tripoli.

—— Voyage to the Levant. London, 1702. pls. & map. fol. Pre-Linn. 1702.1

—— Reysen over Moscovien door Persien en Indien. Amsterdam, 1711. pls. fol. Pre-Linn. 1711.1

Contains data about various fishes. This is a new work, not an edition of the preceding. Another Dutch ed.: 1714. French and English versions follow.

—— Voyages par la Moscovie, en Perse et aux Indes Orientales, ouvrage enrichi de plus de 300 tailles douces des plus curieuses representent les animaux, les oiseaux, les poissons et les plantes, . . . Amsterdam, 1718. 320 pls. fol. Pre-Linn. 1718.1

—— Travels into Muscov, Persia, and part of the East Indies. 2 vols. London, 1737. Pre-Linn. 1737.1

The accounts of the voyages of this author appeared together in a French ed. in 5 vols. Rouen, 1725. 4°.

This author was a painter, not a naturalist, and his drawings and descriptions of fishes are more interesting than valuable.

Bruyn, *Niklaas de* [1570–1641] Libellus varia genera piscium complectens, pictoribus, sculptoribus, utilis et necessarius. N. de Bruyn inventor. [Amsterdam, 1630 ?] 13 pls. 4°. Pre-Linn. 1630.1

Thirteen plates of fishes engraved by Bruyn, and published by Claes Janssen Vischer.

Bry, *Theodor de* [1528–1598], **Bry,** *Johann Theodore de* [1561–1623], & **Bry,** *Johann Israel de* [–1611]. Collectiones peregrinationem in Indiam orientalem et Indiam occidentalem (Grands et petits voyages), 25 parts. Frankfort-am-Main, 1596–1634. Pre-Linn. 1596.1

For a collation of the "Voyages," *see* Lindsay, J. L. (Earl of Crawford and Balcares) in his "Bibliotheca Lindesiana" no. 3, 1884. fol.; also Catalogue British Museum (Natural History), 1903, vol. I, 270–273.

Buonanni, *or* **Bonanni,** *Filippo* [1638–1725] Museum Kircherianum sive Museum a P. Athanasio Kirchero in Collegio Romano Societatis Jesu jam pridem incoeptum, nuper restitu-

Buonanni, *F.* tum, auctum, descriptum et iconibus illustratum. Romæ, 1709. xii, 522 p. 172 pls. fol. Pre-Linn. 1709.1

Glossopetras, p. 201. Fossil fishes, p. 202. Fishes [dog, hammerhead, saw, sword, shark, ray, flying], p. 268–270. Scales of fishes, p. 360. pls.

For the first description of the contents of Kircher's museum, *see* Kircher, A., Pre-Linn. 1678.2.

The present work appeared in revised and enlarged form as:

Rerum naturalium historia, nempe quadrupedum, insectorum, piscium variorumque marinorum corporum, fossilum, plantarum exoticarum ac præsertim testaceorum exsistentium in Museo Kircheriano edita iam a P. Philippo Bonannio nunc vero nova methodo distributa notis illustrata in tabulis reformata novisque observationibus locupletata a Iohanne Antonio Battarra Ariminiensi philosophiæ professore. Pars prima. Romæ, 1773. xl, 260 p. 47 pls. fol.

Piscium squamæ, p. 90–93, pl. 33. De piscibus, p. 153–166, pls. 37–39.

The text (Pars Prima — all published) is by Buonanni; the annotations by Battara, J., 1773.1 (*q. v.*)

Burckhard, *Jacob.* (*præses*) Disputatio juridica de piscatione. Basel, 1684. 6 pls. 4°. Pre-Linn. 1684.1

M. J. Koleffel, *respond.*

Burgundius, *Vincentius. See* **Vincent de Beauvais.**

Burrish, *Onslow.* Batavia illustrata, or A view of the policy and commerce of the United Provinces, particularly Holland. . . 2 vols. London, 1728. Pre-Linn. 1728.1

A brief account of the manner in which the Dutch carry on the herring fishery, p. 569–576.

Other eds.: London, 1731 & 1742.

Burton, *Robert* or *Richard.* Miracles of art and nature, or a brief description of the several varieties of birds, beasts, fishes, &c. of other countreys. London, 1678. 12°. Pre-Linn. 1678.1

4th ed., 1708. 10th, 1737.

Byam, (*Rev.*) *Francis.* An account of the impression on a stone dug up in the island of Antigua, etc. Phil. Trans. Roy. Soc. London, 1755 (1756), **49,** 295–296. pl. Pre-Linn. 1756.1

The fossil fish here described is refigured by C. R. Eastman in Mem. Carnegie Mus., 1914, **6**, 346–348, and named by him *Mene novæ-hispaniæ*, from Eocene.

C

C., *A.* Bibel-erklärende Kupfer, darauf alle zur jüdischen Geschichte gehörige Dinge, als Thiere, Fische, Bäume, Kräuter, Blumen und Früchte gröstentheils mit natürlichen Farben nach dem Leben vorgestellt werden, nebst einer kurzen Erklärung aus den besten Schriftstellern. Danzig, 1756. 4°. Pre-Linn. 1756.1

C., *C. H. B.*, & **M.,** *C.* The perfect husbandman, or the art of husbandry. London, 1658. 4°. Pre-Linn. 1658.1

Pages 346–355 deal with fishes.

Caesarius, *Johannes.* Plinii libri II de piscibus cum scholiis. Venetiis, 1518. 4°. Pre-Linn. 1518.1

Caille, —— (*Abbé*) *de la.* Observations faites à l'isle de l'Ascension, sur le local, sur les oiseaux, la pêche, la longitude, etc. Mém. Acad. Sci. Paris, 1754, hist., 110; mém., 126. Pre-Linn. 1754.1

Caius, *John* [1510–1573] De rariorum animalium et stirpium historia, liber unus. (In his De canibus britannicis. Londini, 1570, p. 37–122.) Pre-Linn. 1570.1

Several fishes are described.

Other (English) eds.: London, 1724 & 1729; (German) Nuremberg, 1685, & Leyden, 1731.

Camellus, *George Joseph.* *See* **Kamel,** *G. J.*

Camerarius, *Joachim* (*the younger*) [1534–1598] Symbolorum et emblematum ex aquatilibus et reptilibus desumptorum centuria quarta, a J. C. . . . cœpta: absoluta post ejus obitum a L. Camerario, etc. Norimbergiæ, 1604. 4°. Pre-Linn. 1604.1

Emblems 29, 30, 31 and 37 are drawings of fishing subjects.

—— Symbolorum et emblematum ex aquatilibus et reptilibus desumptorum centuria quarta. Francofurti, 1654. Pre-Linn. 1654.1

Forty-six plates and descriptions of fish and fishing.

—— Symbolorum emblematum ex re herbaria et animalibus desumptorum centuriæ IV. 4 partes. Francofurti, 1661. 400 figs. 4°. Pre-Linn. 1661.1

The first edition, 1590–97, consisting of three centuriæ only, has no fishes. The first full edition seems to be 1604.

Others, Frankfurt, 1605, 1672; and Mainz, 1668 & 1677. Each edition seems to have been an augmented one.

Camerarius, born of a medical family in Nuremberg, became a famous physician of that city. He was the author of several books mainly dealing with medicinal remedies.

Camerarius, *Joach.* 400 Wahl-Sprüche und Sinnenbilder, und zwar von . . . Fischen, etc. Maynz, 1671. figs. 8°. Pre-Linn. 1671.1

Camerarius, *Joannes Rudolphus.* Sylloge memorabilium naturæ, XX centuriæ. Tubingæ, 1624–52. Pre-Linn. 1624.1

A later ed. is entitled:

—— Sylloges memorabilium medicinæ et mirabilium naturæ arcanorum centuriæ XX. Editio altera, emendata et quatuor centuriis postumis aucta. Tubingæ, 1683. 1662 p. Pre-Linn. 1683.1

i. Quod pisces respirent casu inventum, pisces in aere diu vivere nequeunt. Cent. VII, pt. LXXVII, p. 486.

ii. Anguillæ etymon, sine parente, sine sexu, sanitati inimica, cur ex anguillarum cadaveribus anguillæ gignantur. Cent. IX, pt. XV, 652.

iii. Barborum piscium caro esui an utilis. Cent. IX, pt. X, 645.

iv. Cur pisces mortui aquis innatant, vivi ad fundum stabulant. Cent. IX, pt. XVIII, 655.

v. Cyprinorum ortus spontaneus. Cent. IX, pt. VIII, 645.

vi. Lucii etymon, crudelitas, ortus, elegans spectaculum ranæ ulciscentis Lucii violentiam. Cent. IX, pt. X, p. 647; 649.

vii. Remora piscis, ore navim sistit, inquisitio causæ ob quam Echeneis moretur naves, Rondeletii opinio de vi remoræ, et Fracastorii de Echineide opinio refellitur et Scaligeri asseritur. Cent. IX, pt. I, 635.

—— An Tinca, umbilico applicata, an Rubia conspecta icteritiam sanare possint. (In Sitonus, Joannes Baptista. Miscellanea medico-curiosa, etc. [2d. ed.] Coloniæ Agrippinæ, 1677, p. 140.) Pre-Linn. 1677.1

Camilli, *Chilini.* Tallinæ vallis ac larii lacus particularis descriptio. (In

Camilli, *C.*
Thesaurus antiquitatum et historiarum Italiæ. Basileæ, 1561, **3**, [5 p.] fol.)
Pre-Linn. 1561.1

Fish-fauna of lake Como and its tributaries.

Campbell, *John* [1708–1775] An exact and authentic account of the greatest white-herring-fishery in Scotland, carried on yearly in the island of Zetland, by the Dutch only, etc. Edinburgh, 1750. iv, 33 p. sm. 8°.
Pre-Linn. 1750.1

Some copies of the 2nd ed., published in 1753, have the title "A true and exact description of the island of Shetland." etc.
Reprinted, Edinburgh, 1885. 6, iv, 33 p. 12°.

Camper, *Peter* [1722–1789] Ob die Fische alle taub und stumm seyn. Stuttgard. Sel. Phys. Oecon., [*c.* 1756], **1**, 405.
Pre-Linn. 1756.1

Candidus, *Decembrus Peter* (also styled **Piercandido Decembrio**) [1399–1477] De animantium naturis ac rebus memoria et annotatione dignis. Editi a Candido feliciter D. L. 1460.
Pre-Linn. 1460.1

74 fishes are described.
This illustrated codex is preserved in the Vatican library. A modern rendition with present day identifications and many notes is:

Killermann, Seb. Das Thierbuch des Petrus Candidus geschrieben 1460, gemalt im 16. Jahrhundert. (Codex Vaticanus Urb. lat. 276). Zool. Annalen, 1914, **6**, 113–221. 8 pls.

Cardano, *Girolamo* [*Hieronymus*] [1501 *or* 08–1576] For memoirs, *see* Mantovani, V. "Vita di Girolamo Cardano, Milanese filosopho, medico, e letterato." Milan, 1821; also Morley, Henry, "The life of Girolamo Cardano of Milan, physician." 2 vols. London, 1854.

—— De subtilitate libri XXI, etc. Basiliæ, et Lugduni, 1550, xlvi, 305 p. fol.
Pre-Linn. 1550.1

The *editio princeps*. Reprinted Paris & Leyden, 1551; Basel & Leyden, 1553. True 2nd ed., Basel & Leyden, 1554. 3rd ed. in Latin, Basel, 1560. Many other eds. (at least 13) of this popular work were issued 1561–1664; 12 before 1584. French versions, Paris, 1556 and 1584; Rouen, 1642; German, Basel, 1559.
Considerable data about various fishes are given.

—— De rerum varietate libri XVII. Basiliæ, 1557. xii, 707, 32 p. ills. fol.
Pre-Linn. 1557.1

First ed. Others: Basel, 1557, 1564, 1580, 1581; Avignon, 1558; Leyden, 1580 — *editio recognita*.
The anatomy of several fishes is described in book VII.

—— Hieronymi Cardani Mediolanensis philosophi ac medici celeberrimi Operum, tomus tertius; quo continentur physica, etc. Lugduni, 1564.
Pre-Linn. 1564.1

Cap. 37. "Piscium differentiæ ac genera," p. 112–139.
Other eds. of the "Opera": Geneva, 1624; Leyden, 1663. (10 vols. each.)

Carleson, *Eduard.* Aufmunterung zur Einrichtung einer Fischerey in Schweden. Stockholm. Mag. 1754, **1**, 107.
Pre-Linn. 1754.1

Casserius, *Jules* [1545–1616] De vocis auditusque organis historia anatomica. 2 vols. [in 1]. Ferrariæ, 1601. ills.
Pre-Linn. 1601.1

—— Pentæstheseion, hoc est de quinque sensibus liber, organorum fabricam, actionem et usum continens. Venetii, 1609. 354 p. figs. fol.
Pre-Linn. 1609.1

Other eds.: Venice, 1627; Frankfort, 1610, 1612, 1632.

—— Nova anatomia, continens accuratem organorum sensilium, etc. Frankfort, 1622.
Pre-Linn. 1622.1

In all these works, Casserius, the pupil and successor of Fabricius ab Aquapendente, describes the eye and ear of various fishes; the pike particularly.

Cassiodorus, *Magnus Aurelius* [*c.* 490–585] For a sketch of his life and works, *see* A. Franz (Breslau, 1872), who says of Cassiodorus: "One can with perfect fairness claim for Cassiodorus the honor of first having brought into cloister life the fostering of science."

—— Opera [*editio princeps*]. Paris, 1579.
Pre-Linn. 1579.1

Other early eds.: Orleans, 1622; Rouen, 1679; & Venice, 1729. The "Epistolæ" therein contained have many notes on fishes and their habits. Among the fishes is the Exormiston, which has been identified by Dr. T. N. Gill as a Leptocephalus.
For a present day version of the "Epistolæ" with a good index, *see:*

"The letters of Cassiodorus, being a condensed translation of the 'Variæ' epistolæ of Magnus Aurelius Cassiodorus." Translation with introduction by Thomas Hodgkin. London, 1886. 560 p. 12°.

Castrillo, *Hernando.* Historia y magia natural, o ciencia de filosofia oculta, con nuevas noticias de los mas profundos mysterios, y secretos del universo visible, en que se trata de animales, pezes, etc. Madrid, 1692. 14, 342, 16 p. 8°.

Catesby, *Mark* [1679–1749] The natural history of Carolina, Florida, and the Bahama islands; containing the figures of birds, beasts, fishes, serpents, insects and plants; . . . Together with their descriptions in English and French. . . . To the whole is prefixed a new and correct map of the countries treated of . . . 2 vols. London, 1731–43. col. pls. Pre-Linn. 1731.1

A second edition of this justly famous work was issued at London, 1754, and a third in 1771. Both were revised and edited by George Edwards. A French version is "Histoire naturelle de la Caroline, Floride, etc." Nuremberg, 1770. gr. fol. A German edition of the plates only, by Eisenberger, N. F., & Lichtensteger, Georg (*q. v.*) is:

—— Piscium, serpentum, insectorum aliorumque nonnullorum animalium nec non plantarum quarundam imagines quas M. Catesby in posteriore parte splendidi illius operis quo Carolinæ Floridæ et Bahamensium insularum tradidit historiam naturalem eiusque appendice descripsit. Additis vero imaginibus piscium tam nostratium quam aliarum regionum auxerunt, et vivis coloribus pictas. Ediderunt N. F. Eisenberger et Georg. Lichtensteger. Norimbergæ, 1750. 46 p. 109 pls. fol. Pre-Linn. 1750.1

A second ed. of this was issued Nuremberg, 1777, in folio. (*See* Catesby, M., 1777.1)

—— Beschreibung von Carolina, Florida und den Bahama Inseln. Nürnberg, 1756. map. gr. fol. Pre-Linn. 1756.1

This early German version is recorded by Engelmann only. Agassiz lists an "Appendix," London, 1748. fol. Neither has been seen by us.

Cato, *Marcus Porcius* [B. C. 234–149] De re rustica. Basiliæ, 1521. 82 p. 8°. Pre-Linn. 1581.1

Contains instructions on the care and rearing of fish in ponds.

—— M. P. Catonis de agricultura, sive de re rustica, liber: post ultimam A. Popmæ editionem . . . Item fragmenta ejusdem scriptoris, ab A. Popma diligenter collecta, restituta. Lugduni-Batavorum, 1598. 8°. Pre-Linn. 1598.1

The best ed. is: "M. P. Catonis de re rustica curante J. M. Gesner." Mannheim, 1781. 105 p. 8°. *See* also in Gesner, J. M. "Scriptores rei rusticæ veteres Latini, etc." 1787, vol. I. 8°.

Cato, *M.*, **Varro,** *Marcus Terentius*, **Columella,** *L. Junius Moderatus*, & **Palladius,** *Rutilius*. Libri de re rustica. Parisiis, 1533. 506 p. fol. Pre-Linn. 1533.1

Other eds.: Paris, 1543; Lugduni, 1549; Leipsic, 1794–95.
See also, Anon. Pre-Linn. "Scriptores rei rusticae."

Cats, *Jacob* [1577–1660] Alle de wercken, se ouden als nieuwe, van de Heer Jacob Cats, Ridderondt Raedtpen Lionaris van Hollandt, etc. Amsterdam, 1655. fol. Pre-Linn. 1655.1

In "Emblemata moralia et œconomica" are three drawn from fishing; nos. 2, 7, and 39.
Other eds.: 1660, 1665, 1712, & 1726.

—— 't Ondekte voordeel van alle wereldsche dingen, afgedeelt volgens de wetten der natuur, en natuurlycke saken, in de vermeerderde wyse jaerbeschryver, verstandige huys-houder, ervaren landt-bouwer, enz. Amsterdam, 1663. 4°. Pre-Linn. 1663.1

Catching salmon with nets and with the hands, pt. III, 182–184.

Caub, *Johann v.* *See* **Cube** *or* **Cuba,** *Johann v.*

Celsius, *A.* (*præses*) Dissertatio de novo in fluviis Norlandiarum piscandi modo. Om et nyt sät at fiska i Norländska elfwar. Inaug. Dissert. Upsaliæ, 1738. 28 p. pl. 4°. Pre-Linn. 1738.1

A. Hellant, *respond.*

Celsius, *Magnus* (*præses*) Dissertatio de naturâ piscium in genere, et piscaturâ. Holmiæ, 1676. 4 p. 4°. Pre-Linn. 1676.1

Joh. Aurivillius, *respond.*

Cerutus, *Benedictus*. Musæum Fr. Calceolarii Jun. Veronensis, a Ceruto incœptum, et ab A. Chiocco luculenter descriptum et perfectum. Veronæ, 1622. figs. fol. Pre-Linn. 1622.1

Pisces, p. 62–98 (in alphabetical order), 2 figs. Fossil fish & fig., p. 428.
See also Chiocco, A., Pre-Linn. 1622.1.

Champlain, *Samuel de* [1567–1635] Les voyages du Sieur de Champlain Xaintongeois . . . Devisez en deux livres, ou journal très-fidèle des observations faites ès descouvertes de la Nouvelle France, etc. Paris, 1613. Pre-Linn. 1613.1

—— Voyages et descouvertes faites en la Nouvelle-France, depuis l'année 1615 jusques à la fin de l'année 1618. Paris, 1619. Pre-Linn. 1619.1

—— Les voyages de la Nouvelle France occidentale dicte Canada, faits par le S$^{r.}$ de Champlain . . . & toutes les decouvertes qu'il a fait . . . [1603–1629] Paris, 1632. Pre-Linn. 1632.1

A revised edition of the above works. This was included (with a biographical sketch of Champlain) by Abbé Laverdière in his "Œuvres de Champlain," etc. 6 vols. Paris, 1870. Available for English readers as:

Champlain, *S.*
The voyages and explorations of Samuel de Champlain [1604–1616] Narrated by himself. Trans. by Annie Nettleton Bourne. Edited with [biographical] introduction and notes by Edward Gaylord Bourne. 2 vols. N. Y., 1906.

Champlain's voyages contain many references to fish and fishing. Garpike and its habits first described in book II, chap. ix.

Chapelle, ——, *de la.* Observation sur un poisson, qui ressemble à peu près à une truite qui fait l'effet d'un baromètre. Mém. Acad. Sci. Paris, 1666–1686 (1733), **1**, hist., 424.
Pre-Linn. 1733.1

Charleton, *Gualtier* or *Walther* [1619–1707] Exercitationes de differentiis & nominibus animalium, cum mantissa de variis fossilium generibus; deque differentiis ac nominibus colorum. Oxoniæ, 1667. fol. Pre-Linn. 1667.1

—— Onomasticon zoicon, plerorumque animalium, differentias & nomina propria, pluribus linguis exponens. Cui accedunt mantissa anatomica; & quædam de variis fossilium generibus. Londini, 1668. 12 figs. 4°.
Pre-Linn. 1668.1

P. 119–165, 224 fishes briefly described with Greek, Latin, and colloquial names. Bones of fossil fishes, p. 256. Glossopetra, p. 262.

Other eds.: London, 1671, 1674, 1763; Oxford, 1678. Copy 1668 ed. in A. M. N. H.

—— Gualteri Charltoni exercitationes de differentiis & nominibus animalium. Quibus accedunt mantissa anatomica, et quædam de variis fossilium generibus, deque differentiis & nominibus colorum. Editio secunda, duplo fere auctior priori, novisque iconibus ornata. Oxoniæ, 1677. 309 p. 17 pls. fol. Pre-Linn. 1677.1

An enlarged ed. of 1667.1. Pisces, pp. 1–106.

Charlevoix, *Pierre François Xavier de* [1682–1761] Histoire et description générale du Japon. 2 vols. Paris, 1736. pls. 4°. Pre-Linn. 1736.1

In vol. II, supplement, 16 species of fish are described. The figures are copied after Kämpfer. 2nd ed., in 9 vols.: Paris, 1754. figs.

—— Journal d'un voyage . . . dans l'Amérique septentrionale, etc. (Histoire de la Nouvelle France. Vol. III.) Paris, 1744. 8°. Pre-Linn. 1744.1

Fishes of St. Lawrence river and lake Champlain; fishing for gar pike and sturgeon in lake Champlain; eel fishing in Canada.

This "Histoire" as a whole or in parts passed through a number of eds.: Paris, 1749; Leyden, 1750 (Dutch); Göttingen & Amsterdam, 1750; The Hague, 1760; London, 1761; and more recently New York, 1865.

Chasler, *Hug.*, & **Seguyn,** *Pet. See* **Seguyn** & **Chasler.**

Chauffour, *Jacques de.* Instruction sur le faict des eaux et forêts, contenant en abrégé les moyens de les gouverner et administrer suivant les ordonnances des roys. Rouen, 1618. 8°.
Pre-Linn. 1618.1

Has some data on fishes and fish-ponds.

Cheselden, *William* [1688–1752] Osteographia or the anatomy of the bones. London, 1733. 20 folios. 56 copper plates. fol. Pre-Linn. 1733.1

Skeleton of ray, and jaws and teeth of pike, Scarus and glossodont.

Chetham, *James* (*of Smedley*) [1640–1692] The angler's vade-mecum; or, a compendious yet full discourse of angling: discovering the aptest methods and ways, exactest rules, properest baits and choicest experiments for the catching all manner of freshwater fish . . . etc. London, 1681. 180 p. 12°.
Pre-Linn. 1681.1

This, the 1st ed., was published anonymously; 2nd ed., London, 1689, 326 p.; 3rd, London, 1700, issued by two publishers simultaneously.

Chetham was a writer of much originality. Copy, 2nd ed., N. Y. P.

Chevalier, *Jean Damien* [1700–1770] Lettres à M. de Jean . . . I. Sur les maladies de St. Domingue. II. Sur les plantes de la même île. III. Sur le Remore et les Halcyons. Paris, 1752. ii, 224. p. 8°. Pre-Linn. 1752.1

Chiocco, *A.* Musæum Fr. Calceolarii Jun. Veronensis, a Ceruto incœptum, et ab A. Chiocco luculenter descriptum et perfectum. Veronæ, 1622. figs. fol. Pre-Linn. 1622.1

Pisces, p. 62–98 (in alphabetical order), 2 figs. Fossil fish & fig., p. 428.

See also Cerutus, Benedictus, Pre-Linn. 1622.1.

Chomel, *Noël.* Dictionnaire œconomique; contenant divers moyens d'augmenter son bien, et de conserver sa santé, etc. 2nd ed. 2 vols. Paris, 1718. fol. Pre-Linn. 1718.1

The 1st ed. not known to us. The third, Paris, 1767. An English version is entitled:

—— Dictionnaire œconomique, or the family dictionary. Done into English. Revised and recommended by R. Bradley. 2 vols. London, 1725. fol.
Pre-Linn. 1725.1

Contains descriptions of different nets for catching all sorts of fish.

Churchill, *Awnsham*, & **Churchill,** *John.* A collection of voyages and travels, etc. 6 vols. London, 1704–1732. illust. fol. Pre-Linn. 1704.1

Cirino, *Andrea* [1618–1664] Liber secundus de natura piscium, in quo Platonis ac cæterorum philosophantium oracula; maris admiranda; piscium natura, virtutes, medicina, monstra et miracula ex probatissimis scriptoribus breviter expenduntur. Panormi [Palermo] 1653. 552 p. 4°.
Pre-Linn. 1653.1

Clauder, *Gabriel* [1633–1691] Thermometrum vivum (a pisce desumto) Misc. Acad. Nat. Cur., 1687, dec. 2, an. 6, observ. 175, p. 354. fig.
Pre-Linn. 1687.1

—— Thermometri vivi nomen tribebitur Cobitidi pisciculo. Act. Regiæ Soc. Sci. Upsal., 1742, 79.
Pre-Linn. 1742.1

Cleghorn, *George* [1716–1789] Observations on the epidemical diseases in Minorca. London, 1751. 8°.
Pre-Linn. 1751.1

A number of fishes named.
A German version is: Beschreibung der Insel Minorca. Gött. Samml. der Reisen., 8. Th.

Clemente, *Africo.* Della agricoltura libri sei, coll' aggiunta del libri intorno alle pescagioni. Vicenza, 1673. 16°. Pre-Linn. 1637.1

Fishing occupies 9 chapters.
Other eds.: Trèves, 1677, 1696; Venice, 1714.

Clusius, *Carolus* [Gall. *Charles de* **l'Escluse**] [1526–1609] For a biography *see* Marven, C. J. "Charles de l'Escluse, sa vie et ses œuvres. 1526–1609." Bull. Féderations Soc. d'Horticult., 1874; also separate, Liège, 1875. 59 p. 8°; also Roze, Ernest. "Biographie et correspondance, [suivies d'un rapprochement historique entre Charles de l'Escluse et Parmentier]." Paris, 1899. sm. 8°.

—— Exoticorum libri x; quibus animalium, plantarum, aromatum, aliorumque peregrinorum fructuum historiæ describuntur; item Petri Bellonii observationes, eodem Carolo Clusio interprete. Antverpiæ, 1601. figs. fol.
Pre-Linn. 1601.1

Not seen. Title from Bosgoed. Better known is:

—— Exoticorum libri decem; quibus animalium, plantarum, aromatum, aliorumque peregrinorum fructuum historiæ describuntur. Item Petri Belonii observationes, eodem Carolo Clusio interprete. Antverpiæ, 1605. viii, 378 p. 273 woodcuts. fol.
Pre-Linn. 1605.1

Sixteen fishes are described and shown in curious woodcuts, pp. 135–144. Fishing with the cormorant, p. 106.
A French version is:

—— Histoire des drogues, épiceries et de certains médicamens simples qui naissent des Indes, tant Orientales qu' Occidentales. Lyon, 1619. 8°.
Pre-Linn. 1619.1

Cneiff, *Johan David.* Tanckar huru en tilbörlig Landthushållning skyndsammast synes kunna uphjelpas i Oesterbottn, wälment yppade af . . . och til trycket befordrade af Riksens Högloflige Ständers Manufaktur-Contoir. Linköping, 1757. 333 p. 12°.
Pre-Linn. 1757.1

Treats of fish-culture.

Cockayne, *Benjamin.* Rules for angling. 33 folios. MS.
Pre-Linn. 1670.1

The original MS. is said to have been written in 1670. Transcript in N. Y. P.

Coenen, *Adriaan.* Vischboek van Adriaan Coenen, zoon van Schilperoort. Dit Vis, Booc, veergadert ende gescreven van mij A. Coenen soen, geboren op de dorpe van Scheiveninghe Een visschers dorpe in de Noortsee leggende een cleijn mijlken van den vermaerden Hage in Hollant die is in veel landen wel bekent. Anno 1577 begonnen (–1578) Pre-Linn. 1577.1

This is a MS. work cited by Bosgoed from the Koninklijke Bibliothek te 's Gravenhage (The Hague). It consists of 410 folios of colored figures.

Coetlegon, *Denis de* [–1749] Universal history of arts and sciences. London, 1745. fol. Pre-Linn. 1745.1

Fishing, vol. I, p. 1007–12.

—— A tour through the animal world, or, an . . . account of near four hundred animals, birds, fishes . . . etc. London, 1746. v, 173 p. 172 pls. 12°.
Pre-Linn. 1746.1

Cohausen, *J. H.*, & **Nuenning,** *J. H.* *See* **Nuenning** & **Cohausen.**

Coker, *N.* Survey of Dorsetshire, containing the natural history of that country. London, 1732. 6 pls. map. fol. Pre-Linn. 1732.1

Contains observations on fishes.

Colbiörnsen, *Frid.* (*respond.*) Dissertatio de pisce, qui Jonam deglutivit. Hafniæ, 1744. 4°.
Pre-Linn. 1744.1

Christ. Rœde, *præses.*

Cole, *A.*, & **Culpepper,** *Nich. See* **Bartholinus,** *C.*, 1668.1.

Colerus, *Johann.* Oeconomia ruralis et domestica. Darin das gantz Amphaller treuer Haus-Vätter, Haus-Mütter begriffen. Auch Wild- und Vögelfang, Fischereyen, etc. 2 parts. Mäynts, 1656. 45 col. pls. 8°.
Pre-Linn. 1656.1

Other eds.: Mainz, 1665, 1680. Frankfurt, 1672, 1686, 1692. 4°.

Colerus, ——. Calendarium perpetuum. Wittenberg, 1627.
Pre-Linn. 1627.1

Contains notes on Swiss fishes.

Collaert (*also written* **Collard**), *Adrian* [*c.* 1520–1567] Piscium vivæ icones in æs incisæ et editæ ab Adriano Collardo. Antwerp, *c.* 1580. 26 pls. 4°.
Pre-Linn. 1580.1

"Ungewiss ist es, ob diese Stiche von einem älteren, um 1567 gestorbenen, oder von einem jüngeren Meister desselben Namens (welcher 1597 als Genosse der Malergilde des S. Lucas in Amsterdam erwähnt wird) herrühren." — Carus, J. V. Geschichte der Zoologie, p. 319. München, 1872.

—— Piscium vivæ icones inventæ ab Adriano Collardo, et excusæ a Nicolao Joannis Visscher, anno 1634. Amstelodami, 1634. 20 pls. fol.
Pre-Linn. 1634.1

This work is said to contain 25 plates of fishes, but the copy in the Stuart collection in the library of the A. M. N. H. has 19, plus an engraved title-page. In the same collection is a smaller volume in 4°, containing 8 plates and a title page without signature, date or place of publication, but bearing the words "Piscium vivæ icones." Careful comparison of these figures with the larger above shows beyond doubt that they were engraved by Collaert.

Collins, *Samuel* (*Medicus*) [1618–1710] A systeme of anatomy treating of the body of man, beast, birds, fish, etc. 2 vols. London, 1685. 74 pls. fol.
Pre-Linn. 1685.1

Anatomy of 22 fishes given. The generative organs of a fish, vol. I, chap. xxxiv; description of the reproductive organs of a shark, p. 658 ff., pl.

Collinson, *Peter* [1694–1768] For a biographical sketch *see* Fothergill, J., "Some account of . . . P. Collinson, etc." London, 1770. 18 p. portr. 4°.

—— Observations on the hardness of shells and on the food of the soalfish. Phil. Trans. Roy. Soc. London, 1744 (1746), **43**, 37–39.
Pre-Linn. 1746.1

—— Observations on the Belluga stone. Phil. Trans. Roy. Soc. London, 1747 (1748), **44**, 451. 2 pls. 6 figs.
Pre-Linn. 1748.1

The "Belluga" here referred to is an Acipenser found in the Volga.

Colonna, *Fabio. See* **Columna,** *Fabius.*

Columella, *Lucius Junius Moderatus* [*fl.* 1st cent.] For a sketch of his life and writings, with notes and references, *see* Barberet, N. "De Columellæ vita et scriptis." Nantiaci, 1887. 128 p. 8°.

—— De re rustica libri xii (In Scriptores rei rusticæ, Venice, 1472 fol.)
Pre-Linn. 1472.1

The first edition of this collection which was many times republished, at least 20 editions having appeared before 1595.
The first separate edition of Columella's work seems to be:

—— De re rustica libri xii, Bologna, 1494.
Pre-Linn. 1494.1

Other early eds. are: 1514, 1520, 1529, 1533, 1535, 1541, etc. Early German versions: 1538 & 1612; the best is by M. C. Curtius. "Zwölf Bücher von der Landwirtschaft." Hamburg & Bremen, 1769. Italian translations: 1544, 1554, 1564. French versions: 1551 & 1556. In English we have:

—— Of husbandry in twelve books, and his book concerning trees, translated into English . . . London, 1745. xiv, 600 p. 4°.
Pre-Linn. 1745.1

Book viii, cap. 16, Concerning fishes and their food; cap. 17, concerning the locating of fish ponds.
An earlier edition: London, 1744.

Columella, *L. J. M.*, **Cato,** *M.*, & **others.** Libri de re rustica. Parisiis, 1533. 506 p. fol.
Pre-Linn. 1533.1

Other eds.: Paris, 1543; Lugduni, 1549; Leipsic, 1794–95.
See also Cato, M., Varro, M. T., & others, Pre-Linn. 1533.1.

Columna, *Fabius* [1567–1650] For a sketch of his life, *see* that by J. Plancus in item 1744.2 below.

—— Phytobasanos seu plantarum aliquot historia; accessit etiam piscium aliquot, plantarumque novarum historia. Neapoli, 1592. xiv, 120, 32, 8 p. ills. 4°.
Pre-Linn. 1592.1

Squatina & Pastinaca figured and described.

—— Minus cognitarum stirpium aliquot, ac etiam rariorum nostro coelo orientum, Ekphrasio . . . Item de aquatilibus, aliusque; animalibus quibusdam paucis libulellus . . . opus nunc primum in lucem editum. Romæ, 1606. vi, 340, lxxiii, p. figs. 4°.
Pre-Linn. 1606.1

Two rays described. Second notice of object called "Glossopetra" (shark's tooth). Other fossil fish remains in chap. xxi.
Another issue: Romæ, 1616. 4°.

—— Aquatilium et terrestrium aliquot animalium aliarumque naturalium rerum observationes. Romæ, 1616. Pre-Linn. 1616.1

—— De glossopetris dissertatio. (In his Tract. de purpura. Romæ, 1616, 31 p. 4°.) Pre-Linn. 1616.2

"Hac ostenditur Melitenses linguas serpentinas, sive glossopetras dictas, non esse lapideas, ut quidam asserunt, sed osseas & carchariæ, lamiæ sive canicularum & similium dentes, maris æstu olim terra tenui & lutosa obrutos." — Gronow.

Other eds. are: Kiel, 1675, & Rome, 1678 & 1752.

—— Dissertatio de glossopetris (In his Historia stirpium rariorum. 1744.) Pre-Linn. 1744.1

This is also appended to A. Scilla's "De corporibus marinis lapidiscentibus." Rome 1747, and in its other editions (1752, 1759).

—— Phytobasanos cui accessit vita Fabii et Lynceorum notitia adnotationesque in Phytobasanos J. Planco Ariminensi auctore. (Piscium aliquot . . . historia. J. Planci appendix ad vitam F. Columnæ) Florentiæ, 1744. lii, 134, 2 p. 38 pls. 4°. Pre-Linn. 1744.2

Comenius, *John Amos* [1592–1670] Janua linguarum. Lesna, 1631. Pre-Linn. 1631.1

Westwood and Satchell remark of this work that it "is a sort of encyclopædic phrase-book, each of the 100 chapters containing the words used in a separate art, science or trade, and explaining them by means of the context." It contains a description of the art of fishing.

English editions are:

—— The gate of tongues unlocked and opened, or else a seminary or seedplot of all tongues and sciences. London, 1639. Pre-Linn. 1639.1

In Latin, English and French.

—— Latinæ linguæ janua reserata. The gate of the Latine tongue uulocked. London, 1650. 8°. Pre-Linn. 1650.1

Other eds.: London 1658 & 1670; all in Latin, English, & French.

Commelin, *Caspar* [1667–1731] Observationum anatomicarum collegii privati Amstelodamensis. 2 vols. Amstelodami, 1667–1673. pls. 12°. Pre-Linn. 1667.1

In the first part, the anatomy of the carp and pike is given; in the second, there are figures and descriptions of the pancreas of various fishes.

Conny, *Robert* [*c.* 1645–1713] Letter concerning a shower of fish. Phil. Trans. Roy. Soc. London, 1698, **20**, 289–290. Pre-Linn. 1698.1

Conrad von Megenberg. *See* **Konrad von Megenberg.**

Conringius, *Hermannus* [1606–1681] J. Dubravii . . . De piscinis libri v . . . Omnia H. Conringii cura iterum edita & . . . purgata, cum præfationibus. 1671. 4°. Pre-Linn. 1671.1

See also Dubravius, J. (this section).

"In 1657 H. Conringius collected the treatises of several old writers on fish-ponds and fish and fishing, and printed them at Helmstadt in a quarto volume without collective title-page but with continuous register. By the collector, who reads as well as gathers, this book will be highly prized. It contains the treatise of Dubravius 'de piscinis'; portions of Varro's third book; chapters LIV–LVI of Pliny's ninth book; book twenty of the 'Geoponika' of Cassianus Bassus; excerpts from Crescentius and Heresbachius concerning fish-ponds, and the book on fishing from the latter's 'Thereutices.' " — Westwood & Satchell.

Cooke, *Edward.* A voyage to the South Sea, and round the world, perform'd in the years 1708, 1709, 1710, and 1711. 2 vols. London, 1712. vol. I, 456 p.; vol. II, 318 p. Pre-Linn. 1712.1

Vol. I. Fishes on coast of Brazil. p. 27. pl.; fishes of Chile, p. 66; Juan Fernandez, p. 115. pl.; Lobos Is. (sun fish), pp. 120, 123, 128. pl. Thrashers and sword fishes kill whales, pp. 173 & 317. Fishes of Peru, p. 210; Galapagos Is., p. 317. pl.; Tres Marias, p. 329; Lower California, pp. 340–344. 2 pls.

Coppier, *Guillaume.* Histoire et voyage des Indes Occidentales, etc. Lyon, 1645. 184 p. Pre-Linn. 1645.1

Des poissons marins, p. 94–115. Copy, A. M. N. H.

Coppini, *Carlo Franc.* Prigioni, e morte delli pesci, raccolte de diversi eccellenti authori. Dal Signor Dottore C. F. C. Roma, 1655. viii, 234, xxvi p. 8°. Pre-Linn. 1655.1

Cornelius, *Georgius.* Piscatio philosophica excellentiæ Ill^{me} ac Reverendissime D. D. Georgii Cornelii Eclesie Patavine Episcopi dicata [1662]. 43 pls. 12°. Pre-Linn. 1662.1

Has 19 plates of fishing scenes.

Corvinus, *Georgius Ludovicus.* Dissertatio botanico-medica inauguralis de Scilla, &c. Altorfi, 1715. 4°. Pre-Linn. 1715.1

A shrimp which is destructive to fishes.

Cotton, *Charles* [1630–1687] The compleat angler. Being instructions how to angle for a trout or grayling in a clear stream. London, 1676. 112 p. 12°. Pre-Linn. 1676.1

This is part II of the second impression of the 5th edition of Walton's "Compleat Angler," 1676; the full title of which reads as follows:

Cotton, *C.*
The universal angler, made so, by three books of fishing. The first by Mr. Izaak Walton; the second by Charles Cotton Esq.; the third by Col. Robert Venables. All which may be bound together, or sold each of them severally. London, 1676. 8°.

Cotton's section of this was sold separately or conjointly with Walton and Venables. From this time on, the work was known as Walton & Cotton's "Compleat angler." For further information as to editions, *see* Walton, Izaak (this section). For post-Linnæan editions, *see* Walton, I., 1759.1, and Walton, I. & Cotton, C., 1893.1.

Cotton, *Charles,* & **Walton,** *Izaac.* *See* **Walton & Cotton.**

Cousin, *Jo.,* & **Le Vasseur,** *Claud.* Ergo pisces carnibus salubriores. Paris, 1637. Pre-Linn. 1637.1

2nd ed.: Paris, 1661.

Cox, *Nicholas.* The gentleman's recreation, in four parts; (*viz.*) hunting, hawking, fowling, fishing. Collected from ancient and modern authors forrein and domestick, and rectified by the experience of the most skilfull artists of these times. London, 1674. x, 284 p. 4 pls. 8°. Pre-Linn. 1674.1

"In this edition the book is not claimed by Nicholas Cox, whose name is appended to the 'Epistle Dedicatory,' in the second and subsequent issues." W. & S.

Cox's book was reviewed in Phil. Trans. Roy. Soc., 1675, **10**, 461–466. Other eds. are: 1677, 1685, 1686, 1697, 1706, 1721, 1731.

Copy 1677 ed., N. Y. P.

This is most accessible to the modern reader in the following form:

The nobleman and gentleman's recreation; viz. The fowler. The falconer. The fisherman. The huntsman. London, (1815?). 8°.

This was again republished — subsequent to 1836.

Coyett, *Balthazar.* Poissons écrevisses et crabes . . . que l'on trouve autour des îles Moluques, et sur les côtes des terres australes: . . . Ouvrage . . . copié sur les originaux de M. B. Coyett, etc. Tome I. Amsterdam, 1718–1719. fol. Pre-Linn. 1718.1

See note under Renard, L., this section.

Cramer, *Abia Georg* (*respond.*) Dissertatio de pisce Torpedine ejusque proprietatibus admirandis exhibens. Inaug. Dissert. Kiloni, 1710. Pre-Linn. 1710.1

Johann Ludwig Hannemann, *præses.*

Crescentiis, *or* **Crescenze,** *Pietro de* [1230–1310] For a life of this author, *see* that in the modern edition of his works in footnote below.

—— Ruralium commodorum libri duodecim finiunt feliciter. Augustinum [Augsburg], 1471. 209 unpaged leaves. Pre-Linn. 1471.1

The first edition (black letter) of a work supposed to have been written early in the 14th century. It has been frequently reprinted and translated. John of Westphalia printed three editions at Louvain, one in 1473.

Versions in various languages follow.

—— Il libro della agricoltura. Florentiæ, 1478. Pre-Linn. 1478.1

The earliest Italian version, which was reprinted at Vicenza, 1490, and several times at Venice.

—— Le liure des prouffits champestres et ruraulx. Paris, 1486. fol. Pre-Linn. 1486.1

The first of many French versions, another being "Le bon manager," Paris, 1533. fol.

—— Trattato dell' agricoltura volgarizato, etc. Venice, 1511. Pre-Linn. 1511.1

The 1st Italian version issued at Venice. Others are: 1519, 1534 ("Opera di Agricoltura"), 1536, 1561 & 1605. A German version was published at Strassburg, 1493, and was many times reissued.

—— De omnibus agriculturæ partibus & de plantarum animaliumque, etc. Basel, 1548. xii, 385 p. figs. Pre-Linn. 1548.1

An earlier Latin ed.: Paris & Strassburg, 1486.

A modern edition, to which is appended a sketch of Crescentiis and an estimate of his work, is: "Trattato della agricoltura . . . Translato nella fevella Fiorentina revisto dallo' Uferigno [B. de' Rossi] (Vita di P. Crescenzi — Osservazione sopra lo scritto di P. Crescenzi) 3 vols. Milano, 1805."

Crescenze indicates the various methods of rendering ponds and inland lakes profitable. He is one of the "old farmers" discussed by Donald G. Mitchell in his "Wet days at Edgewood." (*See* Mitchell, D. G., 1865.1)

Copies of 14th cent. eds. of the above work in H., N. Y. S., & A. P. S.

Crescentio, *Bartholomeo.* Nautica Mediterranea. Roma, 1607. fol. Pre-Linn. 1607.1

Remora as a ship-detainer. pp. 397–398.

Crescenze, *Pietro de.* *See* **Crescentiis,** *Pietro de.*

Cube *or* **Cuba** *or* **Caub,** *Johann von.* For an analysis of the "Hortus" and a critical study of its authorship, *see* Choulant, Ludwig. "Graphische Incunabeln für Naturgeschichte und Medicin . . . des XV und XVI Jahrhunderts." Leipzig, 1858, pp. 20–75. Choulant calls the "Hortus," "das wichtigste Naturhistorie des Mittelalters mit Abbildungen." *See* also Payne, J. F. "On the Herbarius and Hortus Sanitatis." Trans. Bibliog. Soc. London, 1901, **6**, 70 p. illust. 4°. [Payne argues that Cube was not the author of the "Hortus"]

For further bibliographical details as to titles, dates and places of publication, *see* Klebs, ——. "Incunabula Lists, Herbals (The Hortus Sanitatis family)." Papers Bibliog. Soc. Amer., 1917 & 1819. vols. XI–XII. *See* also Everard, H. 1898.1

According to Choulant, Cube's work appeared in two forms which he designates as "Des Kleineren" and "Des grösseren Hortus sanitatis." The first edition of the smaller bears title as follows:

—— Hortus sanitatis auff teutsch ein gart der gesundheit. Mainz, 1485. 359 leaves. 389 figs. Pre-Linn. 1485.1

This edition appeared in March, 1485. Other eds. are: Augsburg (August) 1485, 1486, 1487, 1488, 1493, 1496, 1499; Ulm, 1487.

Four other eds. without place or date are listed by Choulant. All the above, or "Kleineren," eds. are in German and some bear the title "Herbarius zu teutsch," etc.

The "grösseren" Hortus was first published in Latin as follows:

—— Ortus sanitatis. Mainz, 1491. 453 leaves. woodcuts. fol. Pre-Linn. 1491.1

Six other folio eds. appeared in Latin as follows: Venice, 1511; Strassburg, 1536; and four without place or date.

Choulant notes eight German eds. as follows: Strassburg, 1507, 1515, 1521, 1527, 1529, 1536; Augsburg, 1508; & Frankfort, 1533. Low Saxon eds. appeared at Lübeck in 1492, 1510, and 1520. Dutch eds. are: Antwerp 1511, 1514, 1547; Brussels, 1514, & Utrecht, 1538. Paris issued two eds., one in 1539 and one without date.

A different French version bearing the title "Arbolaire," "Herbolaire," or "Le Grant Herbier," ran through six editions.

Haller in his "Bibliotheca Botanica," vol. I, pp. 240–242, lists many other editions seemingly not known to Choulant. The following title is for a good later edition:

—— Hortus sanitatis, quatuor libris haec quæ subsequuntur, complectens. De herbis et plantis, de animalibus et reptilibus, de avibus et volatilibus, de piscibus et natatilibus, etc. Argentorati, 1517. figs. fol. Pre-Linn. 1517.1

The "Hortus" is divided into many short chapters, each (for the most part) with its illustrative woodcut. The edition of 1491 (possibly the best) devotes 106 chapters to fishes. The "Hortus" contains the first known figure of Remora acting as a ship-retarder.

Copies of various early eds. are in H., Y., A. M. N. H., Pa., L. C., & J. C.

The author or compiler of the "Hortus Sanitatis" has been identified as Dr. Johann Wonnecken von Cube, town physician of Frankfort, toward the end of the 15th century.

This remarkable work seems not improbably to have been based in large part on the "Herbarius Moguntinus" which first appeared from the press of Schäffer at Mainz, in 1484, and which enjoyed great popularity as the 16 later editions testify. In any case, it was a compilation of all medical data known at the time of its publication.

Culpepper, *Nich.*, & **Cole,** *A.* *See* **Bartholinus,** *C.* 1668.1.

Cupani, *Francesco* [1657–1711] Panphyton siculum, sive historia naturalis de animalibus, stirpibus et fossilibus, quæ in Sicilia vel in circuitu ejus inveniuntur. Opus posthumum, etc. Panormi [Palermo], 1713. 168 pls. fol. Pre-Linn. 1713.1

For a commentary on this work, *see* Riggio, G. "Corrispondenze scientifiche degli [animali [pesci] figurati nel Panphyton siculum del Cupani." Nat. Sicil., 1882, **11**, 160–163.

Curzon, *H.* The universal library: or complete summary of science. Containing above sixty select treatises. 2 vols. London, 1712. 8°. Pre-Linn. 1712.1

Angling, vol. II, p. 458–467.

Cysat, *Johann Leopold.* Beschreibung des berühmten Lucerner oder Vier-Waldstaetten-Sees . . . Darinnen gemeldet wirdt . . . des Sees Länge, Breitte, Tieffe, und wie mancherley herrlicher guter Fisch in dem selben zu finden . . . etc. Lucerne, 1661. x, 256 p. 4°. Pre-Linn. 1661.1

Fische, p. 20–101.

D

D, *L. B.* Traité des étangs, des viviers, fosses, etc. Paris, 1717. 12°. Pre-Linn. 1717.1

Dale, *Samuel* [*c.* 1659–1739] Pharmacologia, seu manductio ad materiam medicam, in qua medicamenta officinalia simplicia, hoc est . . . animalia, eorumque partes in medicinæ officinis usitata, in methodum naturalem digesta succincte & accurate describuntur. Londini, 1693. 12°. Pre-Linn. 1693.1

Contains system of classification of fishes.
Other eds.: London, 1710 & 1737; Bremen, 1713; Leyden, 1739.

—— An account of a very large eel lately caught at Malden in Essex, with some considerations about the generation of eels. Phil. Trans. Roy. Soc. London, 1698 (1699), **20**, no. 238, 90–97. Pre-Linn. 1699.1

—— The natural history of the sea coast and country about Harwich. London, 1730. 4°. Pre-Linn. 1730.1

First published as above, then included in:

—— The natural history of the sea coast and country around Harwich (In Taylor, Silas. The history and antiquities of Harwich and Dovercourt in the county of Essex. London, 1732. 4°.) Pre-Linn. 1732.1

Another ed.: London, 1742.

Dampier, *William* [1652–1715] For sketches of his life. *see* Smyth in United Service Journ., 1837, pts. ii & iii; & Laughton in Dict. Nat. Biog., and Masefield in citation below.

—— A new voyage round the world, etc. London, 1697. vi, 550 p. 5 maps. 8.° Pre-Linn. 1697.1

Other eds.: London, 1697 (2nd), 1698, 1699, 1703, 1717, 1729 (best); Amsterdam in French, 1698 (2 eds.), 1701, 1705–12, 1711, 1717, 1723; Paris, 1701–05; Rouen, 1715, 1723 (2 eds.); in Dutch, The Hague, 1700; Amsterdam, 1698, 1716–17; Nymegen, 1771–72; in German, Leipzig, 1702, & Colle, 1783.

—— Voyages and descriptions, in three parts, viz.: I. A supplement to the voyage round the world, etc.; II. Two voyages to Campeachy, etc.; III. A discourse of trade-winds, etc. London, 1699. 184, 132, 112 p. 8°. Pre-Linn. 1699.1

Other eds.: London, 1700, 1705, 1729; I (above), French ed., Amsterdam, 1711. French ed. of III, Amsterdam, 1701.

—— A voyage to New Holland, &c. in the year 1699, etc. London, 1703. 162 p. 8.° Pre-Linn. 1703.1

Other eds.: London, 1609, 1729.

—— A continuation of the voyage to New Holland, etc. in the year 1699, etc. London, 1709. 198 p. 8°. Pre-Linn. 1709.1

Both "Voyages to New Holland," in French, Amsterdam, 1711.
Dampier's collected "Voyages" were first published in a "Collection of Voyages" along with those of Wafer, Funnell, and others, London, 1729. They were published separately as "Voyages and Adventures" in 2 vols. London, 1777. 8°; and as "Voyages and Discoveries," 2 vols. London, 1790. 12°. They are best available to the present day reader in Masefield's fine reprint, published by Richards, London, 1906. *See* Dampier, W., 1906.1

"As is well known, Dampier was an acute natural history observer as well as a bold navigator and adventurer, and his observations on the beasts, birds, and fishes he met with during his long voyages are among the best and most trustworthy of his time." — J. A. Allen (Bibl. of Cetacea and Sirenia, 1882. p. 430).

Dapper, *Olfert* [–1690] Beschrijving des Keizerrijks van Taising of Sina; versiert met verscheyde koopere plaeten. Amsterdam, 1670. fol. Pre-Linn. 1670.1

Title from Bosgoed. Brit. Mus. (Nat. Hist.) gives the following title:

—— Gedenkwaerdig Bedryf der Nederlandsche Oost-Indische Maetschappye, op de Kuste in het Keizerrijk van Taising of Sina, etc. Amsterdam, 1670. (in parts.) ills. 4°. Pre-Linn. 1670.2

—— Atlas Chinensis, being a relation of remarkable passages in two embassces from the East India Company of the United Provinces to the Vice-Roy Singlamong, etc. London, 1671. fol. Pre-Linn. 1671.1

Other eds.: Amsterdam, 1672 (Dutch); 1673–1676 (4 German eds.); London, 1673 (English version).

Numerous notes on fish and fishing.

—— Arca temporum reserata sive der Welt eröffnete Zeit- und Geschicht-beschreibung: (ubi tertio loco Trinum marinum, sive die drei an einander hangende Meere, Pontus Euxinus, Propontis, cum Archipelago, mit ihren umliegenden Seen, Flüssen, Thieren, Vögeln, Fischen und Raritäten vorgestellet durch Philonem Chronographum. Augspurg, 1693. fol. Pre-Linn. 1693.1

Davies, *John* (*of Kidwelly*) (*translator*). *See* **Rochefort,** *C. de.* 1666.1.

Debes, *Lucas Jacobson.* Feröernes beskrivelse. Kiöbenhavn, 1673, pls. map. 8°. Pre-Linn. 1673.1

Translated as follows:

—— Fœrœ, & Fœroa reserata; that is, a description of the islands & inhabitants of Fœrœ . . . Wherein several secrets of nature are brought to light, etc. Englished by J[ohn] S[terpin]. London, 1676. xii, 408 p. 8°. Pre-Linn. 1676.1

Reviewed in Phil. Trans. Roy. Soc. 1675, **10**, 456–460.
Fishes on p. 460.

—— Natürliche und politische Historie der Inseln Faröe, worinn die Luft, Grund und Boden, Gewässer, Thiere, Vögel, Fische, etc., das Naturel, die Gewohnheiten, Lebensart der Einwohner dieser Inseln und ihre Verfassung beschrieben werden. Kopenhagen & Leipzig, 1757. pl. 8°. Pre-Linn. 1757.1

De Laet, *Jean.* *See* **Laet,** *Joannes de.*

De l'Escluse, *Charles.* *See* **Clusius,** *Carolus.*

Delius, *Heinrich Friedrich* [1720–1791] Von der kalten Electricität des Zitterfisches. Erl. Gel. Anmerk., 1752, no. 50. Pre-Linn. 1752.1

Denison, *Alfred* (*Editor*). *See* Boecxken, under Anonymous titles.

Dennys, *John* [–1609] For critical remarks on the man and his book, *see* Marston, R. B., 1894.1. For further notes, *see* also Westwood & Satchell, 1883.1. The book is extensively noticed with considerable citations in an article in "Censura Literaria," 1809, **10**, p. 266.

—— The secrets of angling; teaching the choisest tooles, baytes and seasons, for the taking of any fish, in pond or river: practised and familiarly opened in three bookes. By J. D.[ennys] Esquire. London, 1613. 30 leaves. 8°. Pre-Linn. 1613.1

—— The secrets of angling: . . . Augmented with many approved experiments. By W. Lauson. London, 1620. 35 leaves. 8°. Pre-Linn. 1620.1

Other issues of Lauson's augmented ed.: London, 1630 & 1652.
This work is most accessible to the modern reader in the following forms:
"The secrets of angling." Reprinted in Edward Arber's "An English Garner." 1877, vol. I, pp. 141–198; and as reprinted eds.: London, 1811, 1883, & Edinburgh, 1885.

Denso, *Johann Daniel* [1708–1795] Neue bestätigte Erfahrung vom Gehöre der Fische. (In his Physikalische Bibliothek. Rostock, 1756, **2**, 188.) Pre-Linn. 1756.1

Various other articles on fish are contained in this volume.

Denton, *Daniel* [*fl.* 1670] A brief description of New York, formerly called New Netherlands. London, 1670. 21 p. 8°. Pre-Linn. 1670.1

The rivers of Long Island are said to be "very well furnished with fish, as basse, sheepsheads, place, pearch, trouts, eels, turtles and divers others." This is the first printed reference to Long Island fishes.

Denys, *Nicolas.* Description géographique des côtes de l'Amérique septentrionale, avec l'histoire naturelle du pays. 2 vols. Paris, 1672. 12°. Pre-Linn. 1672.1

Some notes on the cod fishery.
A German version is:

—— Summarische Nachricht von dem Bakkeljau- und Stockfisch-Fang bei Terreneuf, in den nordlichen Theilen von America, aus den Schrifften des Herrn Denys gezogen. (In Zordrager, C. G. C. G. Zordragers alte und neue Grönlandische Fischerei und Wallfischfang, &c. Leipzig, 1723. 4°.) Pre-Linn. 1723.1

Derham, *William* [1657–1735] Physico-theology or a demonstration of the being and the attributes of God from the works of creation. London, 1713. 8°. Pre-Linn. 1713.1

Swim-bladder and eyes of fishes considered.
This is the 1st ed. of a book which became immensely popular and ran through many editions. At least 7 were issued at London, 1713–1798, and 2 at Glasgow. Of versions in foreign languages there are: 5 French; 3 German; 2 Dutch; 2 Danish; 1 Swedish, and 1 Italian, before the year 1800. Two have been found.

Derham, *W.*

—— Dimostrazione della essenza ed attributi d'Iddio dall' opere della sua creazione; tradotta dall' Inglese. Firenze, 1719. 4°. Pre-Linn. 1719.1

—— Physico-theologie, eller til Gud ledande naturkunnighet, öfversatt af A. N. Stockholm, 1736. 606 p. pl. 8°. Pre-Linn. 1736.1

Deslandes, *A. F.* Sur la génération des soles et des chevrettes. Mém. Acad. Sci. Paris, 1722 (1724), hist., 19–20. Pre-Linn. 1724.1

Eggs of sole attached to shrimps.

—— Observations sur les maqueraux et les sardines, poissons très communs en Bretagne, etc. Mém. Acad. Sci. Paris, 1725 (1727), hist., 2–3. Pre-Linn. 1727.1

—— The production of sole fish [from shrimps] Gentleman's Mag. Hist. Chron. [Urban's], 1753, **23**, 575–576. Pre-Linn. 1753.1

Eggs of sole attached to shrimps.

—— Recueil de differens traitez de physique et d'histoire naturelle propres à perfectionner ces deux sciences. 3 vols. Paris & Bruxelles, 1736. illust. 8°. Pre-Linn. 1736.1

Lettre sur la pêche des saumons, etc. Vol. I, p. 161–196.

Other eds.: Paris, 1748, 1753, 1764; Brussels, 1736, 1753; Amsterdam, 1737.

Dezallier d'Argenville, *Ant. Jos. See* **Argenville,** *Ant. Jos. Dezallier d'.*

Dioscorides, *Pedianus* or *Pediacus Anazarbanus* [*fl.* 1st *or* 2nd cent. A. D.] De materia medica. Colle, 1478. Pre-Linn. 1478.1

In book II are noted 5 or 6 fishes from the standpoint of use in medicine or as food.

First edition of a work which passed through a multitude of reissues, 57 being listed by Boehmer, who says that Dioscorides has also had scores of commentators.

A modern ed. of the works of Dioscorides was published at Leyden, 1906.

Copies: 1st ed., L. C.; 1499 ed. Opera (premier ed. in Greek), N. W. & Surg.

Dodd, *James Solas* [1721–1805] An essay towards a natural history of the herring. London, 1752. viii, 178, 11 p. pl. 8°. Pre-Linn. 1752.1

Döbel, *Heinrich Wilhelm.* Von einer Forelle mit Characteribus und Buchstaben. Bressl. Natur u. Kunstgeschichte, 1718, 3. Vers., 689. Pre-Linn. 1718.1

—— Jäger-Practica oder der wohlgeübte und erfahrene Jäger. [n. p.] 1746. Pre-Linn. 1746.1

Thirty-four fishes referred to. Reproduction in eel. New ed., Neudamm, 1912. Concerning this work, *see* Eberts, "[Discussion of] Heinrich Wilhelm Doebels Jäger-Practica. 1746." Allgem. Fischerei-Zeitg., 1913, 38. Jahrg., 118–120.

Donati, *Antonio* [1606–163–] Trattato dei simplici pietre et pesci marini, che nascono nel lito di Venetia, la maggior parte non conosciuti da Teofrasto, Dioscoride, Plinio, Galeno ed altri scrittori, diviso in duo libri. Venezia, 1631. 120 p. 31 pls. 4°. Pre-Linn. 1631.1

Donck, *Adrian van der.* Vertoogh van Nieu-Neder-Land, weghens de gheleghentheydt vruchtbaerheydt, en sobaren staet desselfs. s'Gravenhage, 1650. Pre-Linn. 1650.1

—— A description of the New Netherlands, as the same are at the present time, etc. 2nd. ed. Amsterdam, 1656. Pre-Linn. 1656.1

Reprinted in Coll. N. Y. Hist. Soc., 1841, **2**. ser. **1**.

"Of the fishes," p. 175.

Dos Santos (*Friar*), *João* [–1622] Ethiopia oriental. 2 pts. [in 1 vol.] Evora, 1609. 546 p. Pre-Linn. 1609.1

This was reprinted in Pinkerton's Voyages, 1814, vol. XVI, and in a late Portuguese ed., Lisbon, 1891. More available is the modern Portuguese and English ed.:

Ethiopia oriental (In Theal, G. Mc. C. Records of southeastern Africa, etc. London, 1901, vol. VII.)

Fishes of Sofala (Tremedor=Malapterurus?), p. 243–244. Fishes of Cuama, p. 260. Swordfish fighting whale, p. 323. Fishing with remora, p. 326–327. Sharks of Mozambique, p. 328–330.

Drayton, *Michael* [1563–1631] For a biography, *see* Elton, Oliver. "Michael Drayton." 1906.

—— Polyolbion, or a chorographical description of all the tracts, rivers, mountains . . . of Great Britain. 1613–22. Pre-Linn. 1613.1

In this poem are many allusions to fish and fishing. Westwood and Satchell intimate that it may have served as an antetype of Walton's "Compleat Angler."

The "Polyolbion" is also found in Drayton's works published in 1748 in folio, and again in 4 vols. 1753. 8°.

For notes on the fishes mentioned by Drayton, *see* Carr, J. W., 1898.1.

Du Bartas, (*Seigneur*) *Guillaume de Saluste* [1544–1590] For a sketch of his life and a résumé of his works, *see* Pelissier, G. "La vie et les oeuvres de du Bartas." 1883.

—— Divine weekes & workes; translated by Josuah Sylvester. London,

1608. (24), 544, 193, (23) p. pls. portr. sm. 8°. Pre-Linn. 1608.1

The fifth day of the "Divine weekes and workes" records the creation of sea and river fish.

Other editions of Sylvester's translation are: 1598 (1st ed.), 1605, 1608, 1611 (English and French versions), 1613, 1621, 1633. Each part was printed with a separate title page and dedication and the parts were often reprinted — at least 16 being recorded.

A French version of Du Bartas' complete works is:

—— Les oeuvres de G. De Saluste Sr. Du Bartas. Reveiies corrigees. Augmentees de nouveaux. Commentaires annotations en marge et embellie de figures sur tous les jours de la sepmaine. . . . Dernier edition. 2 parts. Paris, 1611. 457 & 534 p. fol. Pre-Linn. 1611.1

Most available today in reprint in Silvester, Joshua. "Complete works," edited by A. B. Grosart. 1880. 4°.

Du Bartas wrote his great poem (in French) on the divine weeks and works, beginning with the creation and extending to the beginning of the Christian era. The first section was published in 1578; the second in 1584. Data are not at hand for the others. This work sprang into instant popularity and ran through 30 editions in 6 years. The title of the first French edition is not at hand. Many translations of the whole and of its parts were made in English (*see* Lowndes, vol. I, p. 679). Probably the best is that listed above.

Dubravius *or* **Dubraw,** *Janus* or *Johannes* (Bishop of Olmütz) [–1553] Johannes Dubravius Buch von den Teichen und den Fischen etc. in 5 Büchlein. Breslau, 1547. Pre-Linn. 1547.1

—— De piscinis et piscium qui in eis aluntur naturis libri quinque. Moraviæ Prostanna, 1552. 12°. Pre-Linn. 1552.1

These are the 1st & 2nd eds. Others: Zurich, 1559; Leyden, 1596; Nuremberg, 1596, 1623; Helmstadt, 1600 & 1671 (*See* Conringius, H., in this section); London, 1599 (English). This last is entitled:

—— Newe booke of good husbandry, very pleasant and of great profite both for gentlemen and yeomen, conteining the order and manner of making fish pondes, with the breeding, preserving and multiplyinge of the carpe, tench, pike and troute, and also divers kinds of other fresh fish; translated from the Latine. London, 1599. iv, 74 p. pl. 4°. Pre-Linn. 1599.1

A modern version in German was issued [Vienna ?] under the editorship of Wüstner & Kollmann in 1906.

Copy, 1559 ed. in A. M. N. H.

Duchesne, *Légier*. *See* **Quercu,** *Leodegarius à* (*pseud.*).

Dudley, *Paul*. The decreased size of smelt living in a pond to which they had been transplanted, from the Thames river sixty years previously. Phil. Trans. Roy. Soc. London, 1722 (1724), **32**, 231–232. Pre-Linn. 1724.1

Du Halde, *J. B.* [1674–1743] Description géographique, historique, chronologique, politique et physique de l'empire de la Chine, et de la Tartarie chinoise, enrichie de cartes et d'un grand nombre de figures. 4 vols. La Haye, 1736. 4°. Pre-Linn. 1736.1

Fishes; vol. I, p. 42, 43, 191, 210; vol. II, p. 165–166. Methods of fishing; vol. II, p. 168; vol. IV, p. 202.

The 2nd ed. The 1st, 4 vols., Paris, 1735. illust. An English version is:

—— The general history of China . . . done from the French of P. Du Halde [by R. Brookes]. 4 vols. London, 1736. ills. 8°. Pre-Linn. 1736.2

A somewhat abridged German version in 4 vols. was issued Rostock, 1747.

Dupetit, *François Pourfour* [1664–1741] Mémoire sur plusieurs découvertes faites dans les yeux de l'homme, des animaux à quatre pieds, des oiseaux et des poissons. Mém. Acad. Roy. Sci. Paris, 1726 (1728), 69–83. Pre-Linn. 1728.1

—— Mémoire sur le crystallin de l'œil de l'homme, des animaux à quatre pieds, des oiseaux et des poissons. Mém. Acad. Sci. Paris, 1728 (1730), 4–64. Pre-Linn. 1730.1

—— Histoire de la carpe. Mém. Acad. Sci. Paris, 1733, 197–222. 7 pls. — Comm. Litt., Noriberg, 1739, 212–238. Pre-Linn. 1733.1

Durante, *Castore* [1529–1590] Herbario nuovo . . . con figure, che rappresentano le vive Piante, che nascono in tutta Europe, & nell' Indie Orientali, & Occidentali. Con versi Latini, che comprendono le facoltà de i semplici medicamenti. Con discorsi, che dimostrano i nomi, le spetie, la forma . . . dell' herbi, &c. Roma, 1585. xxiv, 492, 43 p. illust. fol. Pre-Linn. 1585.1

Other (Latin ?) eds.; Venetia, 1602, 1636, 1667.

—— Il tesoro della sanita . . . nel quale s'ensigna il modo di conservar la sanita, & prolungar la vita, et si tratta della natura de' cibi, & de' remedii de' nocumenti laro. [n. p.] 1593. Pre-Linn. 1593.1

Durante, *C.*

The N. Y. P. L. has an edition of identical title issued, Venice, 1623, on pp. 269–300 of which various fishes are named and their use considered as food and in medicine.

There are other (Italian ?) editions of 1605, 1663, 1668, 1686, & 1696.

—— Hortulus sanitatis, das ist ein heylsam und nützliches Gährtlein der Gesundheit. In . . . Teutsche . . . versetzt [mit einen Vorwort] durch P. Uffenbachium. Franckfort, 1609. xvi, 1081, (50) p. illust. 4°.
Pre-Linn. 1609.1

A German version of the "Herbario."

—— Theatrum plantarum, animalium, piscium et petrarum. Venetiæ, 1636.
Pre-Linn. 1636.1

Another ed.: 1656.

Duret, *Claude* [–1611] Histoire admirable des plantes et herbes esmerveillables et miraculeuses en nature: mesmes d'aucunes qui sont vrays zoophytes, &c. 1605. illust. 8°.
Pre-Linn. 1605.1

Contains some illustrations of trees producing fish.

Du Tertre, *Jean Baptiste* [1610–1681] Histoire générale des isles de Christophe, de la Guadeloupe, de la Martinique et autres dans l'Amérique, etc. Paris, 1654. viii, 481 p. pls. 3 maps. 8°.
Pre-Linn. 1654.1

Partie iv, traité 1. Des poissons.
Enlarged and republished as:

—— Histoire générale des Antilles habitées par les François; contenant l'histoire naturelle, enrichy de cartes & de figures. Par le R. P. [Jean Baptiste] du Tertre, de l'ordre FF. Prescheurs, de la Congregation de S. Louis, missionnaire apostolique dans les Antilles. 3 vols. Paris, 1667–1671. 8°.
Pre-Linn. 1667.1

Tome II, traité 4. Des poissons. Chap. I. Des poissons de la mer.

Duval de la Lissandrière, *P. Ne'el.* Traité universel des eaux et forêts de France, pesches et chasses, etc. Paris, 1699. viii, 515, xxvii p. 8°.
Pre-Linn. 1699.1

A treatise on the laws controlling fishing and hunting in France.

Duverney, *Joseph Guichard* [1648–1730] Mémoire sur la circulation du sang des poissons qui ont des ouïes et sur leur respiration. Mém. Acad. Sci. Paris, 1701 (1729), (*hist.* 46–50), 226–241.
Pre-Linn. 1729.1

Also contained in "Oeuvres anatomiques," T. II, p. 496–510, of the same author, and in Walbaum, J. J. "Petri Artedi Renovati. Pars. II. Philosophia Ichthyologica." Grypeswaldiæ, 1789, appendix, p. 167–183.

—— Observations sur la circulation du sang dans le fœtus; et description du coeur de la tortue et de quelques autres animaux. Mém. Acad. Sci. Paris, 1699 (1732), 227–274. pls.
Pre-Linn. 1732.1

Heart of carp, pp. 240–245. 2 pls. This section has been reproduced under the following title:
"Observation sur la structure du coeur des poissons." (In Walbaum, J. J. "Petri Artedi Renovati. Pars. II. Philosophia Ichthyologica." Grypeswaldiæ, 1789, appendix, p. 156–167)

—— Observations sur les ouïes des poissons. Mém. Acad. Sci. Paris, 1666–99 (1733), **1**, 280–281.
Pre-Linn. 1733.1

—— Observation sur les poissons femelles. Mém. Acad. Sci. Paris, 1686–1693 (1733), **2**, 122.
Pre-Linn. 1733.2

Du Villard, *Jean.* Description de dix-neuf sortes de poissons qui se trouvent dans le Rhône et le lac de Genève. Genève, 1581.
Pre-Linn. 1581.1

E

Eames, *John* [–1744] An account . . . of a book intituled, Jacobi Theodori Klein " Historiæ Piscium Naturalis promovendæ missus primus Gedani," 1740. 4°. Or the first number of an essay toward promoting the natural history of fishes, etc. Phil. Trans. Roy. Soc., 1742, **42**, 27–33.
Pre-Linn. 1742.1

Eber, *Paul.*, & **Peucer,** *Casp.* Vocabula rei numariæ ponderum et mensurarum graeca, latina, ebraica etc. Additæ sunt appellationes quadrupedum, insectorum, volucrum, piscium, frugum, leguminum, olerum et fructuum communium. Vitebergae, 1551. 16°. Pre-Linn. 1551.1

Other eds.: Wittenberg, 1556, 1558, 1563, 1570, 1574, 1578; & Leipsic, 1559, 1570. *See* also Peucer, C. Pre-Linn. 1550.1.

Eccard, —— (*respond.*) Dissertatio de respiratione piscium. Witteb., 1637. 2 pls. 4°. Pre-Linn. 1637.1

Jo. Sperling, *præses.*

Eden, *Rycharde* [1521–1576] The decades of the newe worlde or west India, etc. Wrytten in the Latin toungue by Peter Martyr of Angleria, and translated into Englyshe by Rycharde Eden. Londini, 1555. Pre-Linn. 1555.1

Contains numerous references to the fishes of the new world, and the first account in English of fishing with the remora.

This work is available in Arber, Edward. "The first three English books on America [1511–1555 A.D.], being chiefly translations, compilations, &c., by Richard Eden." London, 1895. *See* also Martyr, P., this section.

Copy of original edition, J. C. B.

—— The history of travayle in the West and East Indies, and other countreys lying eyther way towardes the fruitfull and ryche Moluccaes: with a discourse of the northwest passage. Gathered in parte, and done into Englyshe by Richarde Eden. Newly set in order, augmented and finished by Richarde Willes. London, 1577. 4°.
Pre-Linn. 1577.1

A compilation of Peter Martyr, Oviedo, and other writers. Fish and fishing in the West Indies described. Fishing with the remora, folios 21–22, and 211–215.

Copy in N. Y. P.

Edwards, *George* [1694–1773] A natural history of uncommon birds and of some other rare and nondescribed animals, quadrupeds, reptiles, fishes, insects, etc.; exhibited in 200 copperplates, from designs copied immediately from nature, and curiously coloured after life; with a full and accurate description of each figure. 4 vols. London, 1743–51. 4°. Pre-Linn. 1743.1

The French version bears title:

—— Histoire naturelle d'oiseaux peu communs: et d'autres animaux rares, etc. London, 1745–51. Pre-Linn. 1745.1

Both editions were issued in parts and are rarely found complete. This work was later republished as "Gleanings of natural history," etc. 1758–64; "Essays upon natural history, etc.," 1770; and "Catalogue of birds, beasts, fishes," etc. 1776. *See* Edwards, G. 1758.1 and 1776.1.

Egede, *Hans* [1686–1758] Omstændelig og udførlig relation, angaaende den Grønlandske missions begyndelse og fortsættelse, samt hvad ellers mere der ved landets recognoscering, dets bescaffenhed, og indbyggernes væsen og leve-maade vedkommende, er befunden . . . Kjøbenhavn, 1738. x, 408 p. 4°. Pre-Linn. 1738.1

Fishes, p. 54–77.

According to Agassiz, the original edition appeared in 1729, and a German translation at Frankfort in the same year. The next Danish edition is entitled:

—— Det gamle Grønlands nye perlustration, eller naturel historie, og beskrivelse over det gamle Grønlands situation, luft, temperament og beskaffenhed; . . . Kjøbenhavn, 1741. vi, 131 p. 11 pls. & map. Pre-Linn. 1741.1

Foreign language versions are: German, Hamburg, 1740; Copenhagen, 1742, 1763; Berlin, 1763, 1769; Dutch, Delft, 1746; French, Copenhagen & Geneva, also Paris, 1763. English, London, 1745. Besides these, there are a number of abridgements in various collections of voyages and travels. Of editions noted, the available titles are:

—— Description of Greenland, etc. translated from the Danish. London, 1745. 8°. Pre-Linn. 1745.1

A 2nd ed.: London, 1888. 225 p. 8°.

—— Beschrijving van Oud-Groenland, of eigentlijk van de zoogenaamde

Egede, *H.*
Straat Davis; behelzende deszelfs natuurlijke historie, standsgelegenheid, gedaante, grensscheidingen, veld-gewassen, dieren, vogelen, visschen, enz. Delft, 1746. 4°. Pre-Linn. 1746.1

"Van de zee-dieren, zee-vogels, en visschen, walvisschen enz., bl. 54–67. De haai en andere visschen, bl. 75–77. Van de gewone bezigheden als jagen en visschen en de noodige gereedschappen daartoe, bl. 84–94." — Bosgoed.

"Egede's work is still one of the best existing on Greenland, and claims most of all the title of truthfulness, the author having been no less than 15 years in that country."

Eglini, *Raphael.* Prophetia halieutica. Tiguri, 1598. Pre-Linn. 1598.1

—— Coniecturæ halieuticæ novæ et admirandæ e notis et characteribus ternorum piscium marinorum ad latera, stupendo prodigio insignitorum, desumptæ. Hannover & Frankfort, 1611. 4°. Pre-Linn. 1611.1

—— Gedanken von der Begebenheit, welche sich in Thoren im August 1748, mit einigen in Blut verwandelten Fischen zugetragen hat. Danzig, 1749. pl. 4°. Abstract in Jena. Gel. Zeit., 1749, 659. Pre-Linn. 1749.1

Eisenberger, *N. F.*, & **Lichtensteger,** *G.* (*editors*). Piscium, serpentum, insectorum, etc. imagines, quas M. Catesby in posteriore parte operis quo Carolinæ, etc. reddidit historiam naturalem, additis vero imaginibus piscium, etc. ediderunt N. F. Eisenberger et G. Lichtensteger. Norimbergæ, 1750. 109 col. pls. fol. Pre-Linn. 1750.1

Explanation of plates in Latin and German. *See* Catesby, M., 1777.1 in this section.

Ellis, *William* [*c.* 1700–1758] The modern husbandman, complete in eight volumes . . . By William Ellis, Farmer, at Little Gaddesden, in Hertfordshire. London, 1750. 8°. Pre-Linn. 1750.1

Vol. III, pt. II, chap. XIII, "Of fishing for trout," etc. Vol. IV, pt. II, chap. IX, "Of making ponds;" chap. X, "Of fishing in the sea."
An earlier ed. is dated 1744–47. This was preceded by "The practical farmer; or the Hertfordshire husbandman," of which there are editions of 1732 (2nd), 1736, and 1737. Not seen, and not known positively to contain fish and fishing.

Elsner, *J. G.* De anguillis viviparis. Misc. Acad. Nat. Cur., 1670, 1. dec., observ. 119, 240. Pre-Linn. 1670.1

Elvas, —— *de.* *See* **Fidalgo de Elvas.**

Engelbrecht, *Joh.* Dissertationes duæ de pisce Ionæ deglutitore. Leipzig, 1702. 4°. Pre-Linn. 1702.1

Enholm, *Johannes Eliæson* (*respond.*) Enfalliga anmärkningar om Ost-Giötha Skäre Boars öfliga fiskesätt i Ostersjön. Inaug. Dissert. [Pehr Kalm, *præses*] Abo, 1753. 46 p. 4°. Pre-Linn. 1753.1

Pisces, p. 8–20. 2nd ed.: Abo, 1754. 28 p.

Ent, *George* [1604–1689] Mantissa anatomica, ad piscium pelagiorum cartilagineorum planorum classem spectans. (In Charleton, Gaultier. Onomasticon zoicon, plerarumque animalium differentias & nomina propria pluribus linguis exponens. London, 1668, pp. 197–213.) Pre-Linn. 1668.1

Rana piscatrix dissected and described — 5 figs.; also Galeus — figure of digestive tract. Also found in Charleton, G. "Exercitationes, etc.," 1677.

Erasmus, *Desiderius* [*c.* 1466–1536] Familiar colloquies of Desiderius Erasmus. Translated by N. Bailey. London, 1725. 12°. Pre-Linn. 1725.1

"Venatio, or fishing with a worm," p. 52–53. "Ichthyophagia, or fish-eating," p. 364–408.

Erhard, *George.* De cyprino monstroso rostrato. Inaug. Dissert. Jena, 1748. 8 p. pl. Pre-Linn. 1748.1

Escher, *H. E.* [*c.* 1626–1710] Beschreibung des Zürich-Sees, wie auch von Erbauung, Zunehmen, Stand u. Wesen löblicher Stadt Zürich, von der Lust und Nutzbarkeit des Sees, von wilden Thieren so sich in und um denselbigen befinden. Zürich, 1692. xx, 416 p. 12°. Pre-Linn. 1692.1

Fish and fisheries of lake Zurich.

Eslenberg, *Carl.* (*respond.*) Dissertatio de piscaturis in Oceano Boreali. Londini Gothorum [Lund], 1750. 4°. Pre-Linn. 1750.1

Sven Bring, *præses.*

Estienne, *Charles* [1504–1564] De Latinis et Græcis nominibus arborum, fructicum, herbarum, piscium, & avium liber: ex Aristotele, Theophrasto, Dioscoride, Galeno, Aëtio, Paulo Aegineta, Actuario, Nicandro, Athenæo, Oppiano, Aeliano, Plinio, H. Barbaro, & J. Ruellio: cum Gallica eorum nominum appellatione. Parisiis, 1536. 8°. Pre-Linn. 1536.1

This work was many times augmented, edited and reissued. There were 17 eds., in French, 1536–1668; 10 Latin, 1536–1629; 8 German, 1579–1607; 6 Dutch, 1566–1627; 6 Italian, 1586–1677; 3 English, 1606– ; 50 eds. in all, 1536–1677.
Estienne possibly took much of his material from an anonymous work of similar title published at Frankfort in 1536. *See* Pre-Linn. Anon. 753.

—— Prædium rusticum, in quo cujusvis soli vel culti vel inculti plantarum vocabula ac descriptiones, earumque conserendarum atque excolendarum instrumenta suo ordine describuntur. Lutetiæ [Paris], 1554. 648 p. 8°.
Pre-Linn. 1554.1

Fish ponds and the rearing of fish.

—— L'agriculture et maison rustique de Charles Estienne, docteur en médicine. Paris, 1564. 4°.
Pre-Linn. 1564.1

Fish, fish ponds, and fishing considered.
The above seems to be the first French ed. Forty other eds. have been noted as follows: 17 French, 1565–1668; 8 German, 1579–1607; 6 Italian, 1581–1677; 6 Dutch, 1566–1627; 3 English, 1600–1616. However, according to Brunet, 30 eds. (presumably in French) were published at Paris, Lyons and elsewhere between 1591 and 1702. Estienne's work was replaced in 1700 by Liger. (*q. v.*) Some foreign language versions follow:

—— L'agricolture et case di villa di Carlo Stephano . . . nuovamente tradotta del Cavaliere Hercole Cato. Venezia, 1581. 4°. Pre-Linn. 1581.1

—— XV Bücher von dem Feldbau, etc. Strasburg, 1598. fol.
Pre-Linn. 1598.1

—— Hofstede en Landthuys. Dordrecht, 1662. 4°. Pre-Linn. 1662.1

For further issues, *see* Estienne, C., & Liebault, J.
"Charles Estienne or Stevens was a member of the celebrated family of Paris printers and scholars of that name, and was himself a printer and physician. His work appears to have been published after he had ceased to print. The treatises, of which it is composed, were originally written in Latin and collected under the title, 'Prædium rusticum.' The author afterwards translated them into French under the title given above. John Liebault, by whom the work was augmented, was his son-in-law." — W. & S.
For titles of the short tracts referred to, *see* Catalogue British Museum (Natural History), vol. II. The first edition of the completed work appeared in 1554.

Estienne, *Charles,* & **Liebault,** *Jean* [*c.* 1535–1596] L'agriculture et maison rustique de Charles Estienne, docteur en médecine; augmenté par Jean Liebault. Lyon, 1565. 16°.
Pre-Linn. 1565.1

—— Maison rustique, or the countrie farme. Compiled in the French tongue by Charles Stevens and John Liebault, doctors of physicke, and translated into English by Richard Surfleet, practitioner in physicke . . . London, 1600. 4°. Pre-Linn. 1600.1

Book IV, chaps. xi–xvi have to do with fishponds and the rearing of fish.
Other eds.: London, 1606, 1616. fol.

—— L'agriculture et maison rustique. Revue et augmentée . . . Rouen, 1608. woodcuts. 4°. Pre-Linn. 1608.1

Eustathius, (*Saint*) (*Bishop of Antioch*) [*c.* 270—*c.* 360] Commentarius in Hæxameron (Leo Allatius editor and commentator) Lugduni, 1629. 4°.
Pre-Linn. 1629.1

In his comments on the work of the "6 days" of the first chapter of Genesis, he refers to the sciæna, scarus, echeneis, and the thresher shark.
This seems to be a translation with comments of a similar work by Saint Basil, and is found in the works of the latter; Paris, 1603, & Antwerp, 1616. It is available today in Migne, J. P. Patrologiæ Græcæ, Paris, 1847, vol. LIII (Latin); & Paris, 1857, vol. XVIII (Greek and Latin in parallel columns). By some the "Hexameron" is accounted a spurious work.

Euthius, *Johannes Aegidius.* De pisce magno, prægrandi & monstroso. Misc. Acad. Nat. Cur., 1696, 3. dec. **4**, observ. 29, p. 76. *Ibid.*, 1697, 3. dec. **5**. Pre-Linn. 1696.1

—— De pisce figura vittæ Gallicanæ vulgo Fontange. Misc. Acad. Nat. Cur., 1697 & 1698, dec. 3, ann. 5 & 6, 145.
Pre-Linn. 1697.1

Evelyn, *John* [1620–1706] Diary, July 23, 1668. Pre-Linn. 1668.1

Under this date is found an identification of bufonites and glossopetras as sharks' teeth.
The earliest edition of this diary is: "Memoirs illustrative of the life and writings of John Evelyn, Esq.; comprising his diary, from 1641 to 1705–06, and a selection of his familiar letters. Edited by W. Bray." 2 vols. London, 1818. 4°.

F

Faber, *Joh.* (*respond.*) Disquisitio de Xiphia sive Gladio. Regiomonti [Königsberg] 1693, 22 p. 4°. Pre-Linn. 1693.1

Phil. Jac. Hartmann, *præses.*

Faber, *Johann Matthaeus* [1626–1702] Observatio de glossopetris. Ephemer. Acad. Nat. Cur., 1676, 1. dec., ann. 6; 7; 8; 9. Pre-Linn. 1676.1

Fabri, *B.* Epitome 4 librorum C. Gesneri de historia animalium quadrupedum, viviparorum, aquatilium & volatilium. Francofurti, 1622. Pre-Linn. 1622.1

Fabri, *Pet. Joh.* Operum volumen prius, in quo 1. panchymicum, sive anatomia totius universi; 2. sapientia universalis sive anatomia hominis et metallorum. Frankfort, 1656. Pre-Linn. 1656.1

In Book I are found certain details concerning fishes.

Fabricius, *George* [1516–1571] Rerum Misnicarum libri VII. Lipsiæ, 1569. 4 pls. 4°. Pre-Linn. 1569.1

Names in Latin and German of various fishes of river Albi, p. 220.

Fabricius, *Philip Conrad* [1714–1774] Commentatio de animalibus quadrupedibus, avibus, amphibiis, piscibus et insectis Wetteraviæ indigenis. Helmstadii, 1749. 56 p. 8°. Pre-Linn. 1749.1

—— (*præses*) Dissertatio de ichthyocolla. Helmstatdii, 1756. 28 p. 4°. Pre-Linn. 1756.1

Stolze, *respond.*

Fabricius d'Aquapendente, *Jerome* [1537–1619] Tractatus de motu locali animalium secundum totum. Venetiis, 1610. 4°. Pre-Linn. 1610.1

Other eds.: 1616 & 1618 (Padua).

—— De totius animalis integumentis. Padua, 1618. 8°. Pre-Linn. 1618.1

Another ed.: Königsberg [Regiomonti], 1642.

—— Tractatus de formatione ovi et pulli. Padovæ, 1621. Pre-Linn. 1621.1

Discusses mode of reproduction and describes the scales of fishes.

—— Opera physico-anatomica prodiere. Patavii, 1625. fol. Pre-Linn. 1625.1

Other Latin eds.: Leipsic, 1678, & Leyden, 1737 or 38; a German version with plates & portrait, Nürnberg, 1673.

"Pauca de generatione et squamis piscium edisserit & figuram galæi dissecti tab. ænea 30 & 31 repræsentavit sed non descripsit." Comment by Walbaum on 1738 edition.

Fahlberg, *Algot.* Angående åhlfiskens alstrande och förökelse. K. Svensk. Vet. Acad. Handl., 1750, **11**, 194–197. Pre-Linn. 1750.1

With remarks by Carl de Geer in a footnote. Erroneously credited by Agassiz and others to Fahlberg & de Geer.

—— Von der Fortflanzung und Bemehrkung der Aale. König. Schwed. Akad. Abhand., 1754, **12**, 199–202. Pre-Linn. 1754.1

See note under Kästner, A. G. this section.
Reprinted, Analecta Transalpina, Venice, [1762], **2**, 298.

Fallours, *Samuel.* A physician of Amboina, whose drawings of East Indian fishes, according to Cuvier served as the basis of the second volume of Renard's fishes of India. *See* note under Renard, L., this section, 1718.1.

Farmer, *John.* The history of the ancient town and once famous abbey of Waltham in the county of Essex, etc. London, 1735. v, 237 p. illust. 8°. Pre-Linn. 1735.1

Contains some observations on fishes.

Farrington, ——. Some account of the charrfish [*Salmo umbla* or *alpinus*], as found in north Wales. Phil. Trans. Roy. Soc., 1755 (1756), **49**, 210–212. — London Mag., 1756 (December). — Hamburg Mag., 1756, **19**, 373. Pre-Linn. 1756.1

Fatio, *J. Ch.* Remarques sur l'histoire naturelle du lac de Genève. Genève, 1730. Pre-Linn. 1730.1

Fishes of Lake Geneva considered.

Feith, *H. O.* Brief van Prior Petrus aan Johan van Ewsum, over de zwanen, de visscherijj enz. te Roden. 1559. Pre-Linn. 1559.1

Ferro, *Giovanni Maria.* Historia naturale di F. Imperato . . . In questa seconda impressione aggiontoui da G. M. Ferro . . . alcune annotationi alle Piante nel libro vigesimo ottavo. Venice, 1672. fol. Pre-Linn. 1672.1

Another ed., 1695. *See* Imperato, F., in this section.

Feuillée, *Louis* [1660–1732] Journal des observations physiques, mathématiques & botaniques faites par l'ordres du Roy sur les côtes orientales de l'Amérique méridionale, & dans les Indes Occidentales, depuis l'année 1707, jusques en 1712. 3 vols. Paris, 1714–25. pls. 4°. Pre-Linn. 1714.1

Notes on some fishes.

—— Journal d'observations faites dans la Nouvelle Espagne et aux îles de l'Amérique. Paris, 1725. 4°. Pre-Linn. 1725.1

This may be one of the three volumes of the above. Not seen. Title from Agassiz. A German edition of the whole or one of its parts is:

—— Beschreibung zur Arzeney dienlicher Pflanzen, welche in den Reichen des mittägligen America in Peru und Chili vorzüglich im Gebrauch sind, nebst verschiedenen andern aus ebendesselben Tageregister physischer Beobachtungen gesammelten und zur natürlichen Historie gehörigen Anmerkungen. 2 parts [in 1 vol.] Nürnberg, 1756–57. 102 pls. 4°. Pre-Linn. 1756.1

Sharks, flying fishes and various other fishes (10 in number) described.

Fibig, *Johann* (*præses*) [–1792] Exercitium juridicum de jure venandi, aucupandi et piscandi. Jenæ, 1638. 4°. Pre-Linn. 1638.1

S. Scheffer, aus Görlitz, *respond.*

Fidalgo de Elvas. Relaçam verdadeira dos trabalhos q̄ ho governador dom Fernando de Souto e certos fidalgos Portugueses passarom no descubrimēto da provincia da Florida. Agora novamente feita per hũ fidalgo Delvas. Evora, 1557. Pre-Linn. 1557.1

This is the very rare first ed. Pre-Linnæan eds. have appeared in English, 1609 & 1686; French, 1685; Dutch, 1706. The first English version is by Richard Hakluyt and is entitled:

—— Virginia richly valued, by the description of the mainland of Florida, her next neighbor. London, 1609. Pre-Linn. 1609.1

French has reproduced this work in his "Historical Collections of Louisiana," 1850, pt. II. It may also be found in a Hakluyt Society reprint, 1851. For a more modern version, *see:* "Narratives of the career of Hernando de Soto in the conquest of Florida as told by a Knight of Elvas." Translated by Buckingham Smith, New York, 1866.

For observations on the fishes referred to therein, *see* Gill, T. N., 1866.2.

The "Gentleman of Elvas" was undoubtedly one of the eight Portuguese adventurers from Elvas who accompanied De Soto to Florida, and one of the four who escaped with their lives.

Figulus, *Carolus* [*fl.* 1540] Ichthyologia seu dialogus de piscibus. Coloniæ, 1540. 8 p. 4°. Pre-Linn. 1540.1

The persons carrying on the dialogue are C. Figulus and J. Sylius. Some 20 fishes of the Moselle are named in Latin and German, but no descriptions are given. Copy, A. M. N. H.

Figulus, *Publius Nigidius* [98–45 B.C.] De animalibus (In Macrobius, Aurelius Theodosius. Commentariorum in Somnium Scipionis libri II; Saturnaliorum conviviorum, libri VII. Venetiis, 1492. fol.) Pre-Linn. 1492.1

According to Walbaum, in book III, chap. XVI, of the "Saturnaliorum," Figulus makes mention of certain fishes.

Another ed. of the above, 1597.

—— De animalibus (In Rutgers, James. Variæ lectiones. Lugduni, 1618. 4°.) Pre-Linn. 1618.1

For present day renderings of the fragmentary remains of this author, *see:*

De P. Nigidii Figuli fragmentis apud scholiasten Germanici servatis. Berolini, 1854. 44 p. [A thesis by Alfred Breysig]

P. Nigidii Figuli operum reliquæ. A. Swoboda editor. Vindoboniæ [Vienna], 1889.

Firens, *Pierre.* Fasciculus rariorum et continuatio rariorum et aspectu dignorum varii generis quæ collegit et in æs incisi curavit Basil. Besler. Nürnberg, 1616–22. Pre-Linn. 1616.1

"Enthält Thierabbildungen ohne Stechernamen. Die Tafeln wurden zu dem Gazophylacium des Mich. Aug. Besler benutzt." Reference and note from Carus, J. V., p. 320.

—— Piscium, quadrupedum, avium vivæ icones in æs incisæ et editæ a Petro Firens. [c. 1650]. 4°. Pre-Linn. 1650.1

Engraved title-page and 19 engravings of fishes.

Fischer, —— (*respond.*) Dissertatio de piscibus. Coburgi, 1679. 4°. Pre-Linn. 1679.1

J. C. Fromman, *præses.*

Fischer, *C.* Fleissiges Herren Auge, oder wohl ab- und angeführter Haushalter; das ist gründlicher Unterricht von Führung eines nützlichen Landlebens und Wirthschaft von Feld- und Ackerbau, Fischerei und Teiche. Frankfurt, 1690. 4°. Pre-Linn. 1690.1

Another ed.: Nürnberg, 1696. 3 pts .4°.

Fischer, *Christian Gabriel* [c. 1690–1751] Dissertatio de bufonite. Regiomonti [Königsberg], 1714. 4°. Pre-Linn. 1714.1

Bufonites are fishes' teeth.

—— Par lapidum: ætites et bufonites. Regiomontani, 1715. 4°. Pre-Linn. 1715.1

Fischer, *Francis Melchior.* Dissertatio de jure piscandi. Argentorati [1719] 22 p. 4°. Pre-Linn. 1719.1

Fischers, *Salamon von Azendorff.* Oeconomische Schatz-Kamer in 4 Theilen bestehend. Hanover, 1716. 8°. Pre-Linn. 1716.1

Is concerned with fish and fisheries.

Flacourt, *Etienne de* [1607–1660] Histoire de la grand isle Madagascar, etc. Paris, 1661. xxi, 471 p. 10 pls. 6 maps. Pre-Linn. 1661.1

Fishes, chapter xli.
First ed.: Paris, 1658.

Flamen, *Albert B.* Icones diversorum piscium tum maris tum omnium ab Alb. Flamen ad vivum delineati, et in æs ab eodem artificiose incisi. . . . Figures de plusieurs sortes de poissons tant de mer, que de l'eau douce dessignez et graves sur le naturel, par Albert Flamen, etc. Paris, 1664. obl. fol. Pre-Linn. 1664.1

This is the general title of the following 6 parts.

i. Diverses espèces de poissons de mer, etc. 12 pls.
ii. Seconde partie de poissons de mer. 12 pls.
iii. Troisième partie de poissons de mer. 12 pls.
iv. Diverses espèces de poissons d'eau douce. 12 pls.
v. Seconde partie de poissons d'eau douce. 12 pls.
vi. Diverses espèces de poissons, tant de mer, que d'eau douce. 7 pls.

—— Diverses espèces de poissons d'eau douce, etc. Paris, 1710. obl. fol. Pre-Linn. 1710.1

Engraved title-page and sixteen engravings of fish and fishing.
Not seen. Title entirely isolated. Possibly a reprint of some part of the above.

Flemming, *H. F. von.* Volkommener deutscher Jäger und Fischer. Leipzig, 1719. 2 parts. pls. fol. Pre-Linn. 1719.1

Other eds.: Leipsic, 1724, 1748, 1749.

—— Der wohl unterrichtete deutsche Fischer, welcher Anleitung giebt, wie die Teiche anzulegen, die Fischereyen anzustellen, und allerhand Fische beschreibet, etc. Leipzig, 1724. fol. Pre-Linn. 1724.1

Forer, *Conrad* or *Cunrat* (*translator*) Gessners Fischbuch. Die ausführliche Beschreibung und lebende Conterfactur aller und jeder Fischen. Durch C. Gessner in Latein erstmals beschrieben, hernach von C. Forer ins Teutsch gebracht. Zürich, 1563. vi, 202 Blätter. fol. Pre-Linn. 1563.1

Forer's German version was also issued at Zurich, 1563 (2nd ed.), 1575; Frankfurt, 1598; & Heidelberg, 1606.
See also Gesner, C., this section.

Fortin, *François.* Les ruses innocentes, dans lesquelles se voit comment on prend les oyseaux . . . & de plusieurs sortes de bestes . . . Avec les plus beaux secrets de la pesche dans les rivières & dans les estangs. Et la manière de faire tous les rets & filets qu'on peut s'imager. Par F. F. R. D. G. dit le Solitaire Inventif. [F. Fortin]. Paris, 1660. xvi, 288, 54 p. 4°. Pre-Linn. 1660.1

The initials used by the author are thus interpreted: Frère François Fortin, religieux de Grandmont.
Copy, N. Y. P.
Other eds.: Paris, 1688; Amsterdam (2 separate eds.), 1695. 2 vols. Next as:

—— Délices de la campagne, ou les ruses de la chasse et de la pêche, . . . avec les plus beaux secréts de la pêche et la manière de faire les rets et les filets, augmenté d'un dictionnaire de tous les termes de chasse, de pêche et de filets, . . . 2 vols. Amsterdam, 1694. Pre-Linn. 1694.1

Other eds.: 1699, 1700, 1732.
On this work Louis Liger based his "Amusemens de la campagne." In fact several editions of his work reproduced in its entirety volume one of "Les ruses." *See* Liger, Louis, this section.

Fournival, *Richard de* [*fl.* 13th *or* 14th cent.] . . . De vetula. [Rome?, *c.* 1470]. Pre-Linn. 1470.1

This work, now known to be by De Fournival, was formerly attributed to Ovid, and was first printed, probably at Rome, in 1470, under the title "P. Ovidii Nasionis liber de vetula," and at Cologne, 1479. Afterward the authorship came into doubt, for it was combined with another work and published under the title "Brunellus Vigelli, et vetula Ovidii, seu opuscula duo auctorum incertorum," etc. Wolferbyti, 1662.
The "De vetula" was translated into French by Jean Lefevre about the middle of the 14th century and remained in MS. until 1855 when it was published in Paris. A later and more critical edition was issued by Aubry in his "Trésor de pièces rares ou inédites" as:

La vieille, ou les dernières amours d'Ovide, poëme français du xiv$^{\text{me}}$ siècle traduit du Latin de Richard de Fournival . . . et précédé de recherches sur l'auteur du Vetula, par Hyppolyte Cocheris." Paris, 1861.
The passage in "La Vieille," which treats of fishing is headed "Comment Ovide tendait aux poissons," and consists of 68 lines.

"De Fournival's work cannot but be interesting to the angling bibliophile, as showing that more than four hundred years ago (and probably about a hundred and fifty years before the date of the 'Book of St. Albans') most of the modern modes of fishing were practised; for instance: the worm, the fly, the torch and spear, the night-line, the eel-basket and fork, etc." — W. & S.

Francese, *Gio. Germano.* Trattato alle figure anatomiche della piu principali animale terrestri, aquatili, e volatili, con la simpatia convenienza che hanno, o in parte, o in tutto con il corpo humano. Neapoli, 1625. fol. figs.
Pre-Linn. 1625.1

Franciscus, *Erasmus* [1627–1694] Ost- und West-Indischer, wie auch Sinesischer Lust- und Stats-garten, etc. In drey Haupt-Theile unterschieden. Nürnberg, 1668. xxxvi, 1762 p. 66 pls. fol.
Pre-Linn. 1668.1

Härings-fang ausfürlich beschrieben, p. 25–29. Beschreibung verschiedener Fische, p. 21–35; 150–153; 449; 452; 681; 926; 960; 986; 999; 1027; 1392. Sinesische Fische, p. 1422. Der Torpedo, p. 1422.

—— Guineischer und americanischer Blumen-Pusch, welcher einen ergetzlichen Geruch mancherley mercklicher Eigenschafften, wunderlicher Thiere, Vögel, Fische, fremderweisen Sitten Gebräuche selbiger Länder . . . Nürnberg, 1669. 399 p. pls. 8°.
Pre-Linn. 1669.1

Fishes and fishing, chap. XI, p. 221–239.
Copy, A. M. N. H.

Francus, *Antipas.* Divinorum characterum halecum [herring] duarum in littore Nortwegico 1587 captarum vera lectio et explicatio. 1591. 4°.
Pre-Linn. 1591.1

Frank, *Richard* [1624–1708] Northern memoirs, calculated for the meridian of Scotland. . . . Together with choice collections of various discoveries . . . observations, theological notions. . . . To which is added, The contemplative and practical angler. . . . Writ in the year 1656, etc. London, 1694. xxix, 304 p. 16°. Pre-Linn. 1694.1

Reviewed in Retrospective Review, **8**, 170–194. A new ed., with preface and notes by Sir Walter Scott. Edinburgh, 1821.
Copies of both eds., N. Y. P.

Frankenau, *Georg Frank von (præses)* [1643–1704] Dissertatio de anguillis. Medic. Siles. Satyra, Argentorati [Strassburg], 1673. 4°.
Pre-Linn. 1673.1

Matthæus, *respond.*
Not seen; title from Walbaum. Agassiz gives date, 1675. Walbaum & Boehmer say Heidelberg, 1675.

Franz, *or* **Frantzius,** *Wolfgang* [1564–1628] Animalium historia sacra, in qua plerorumque animalium præcipuæ proprietates in gratiam studiosorum, etc., breviter accomodantur. In academia Wittebergensi ante annos aliquot dictata etc. Jam denuo emendatius et correctius edita; triplici indice, scilicet capitum, rerum et locorum e scriptura, nec non adagiorum aucta. Amstelodami, 1643. 638 p. 12°.
Pre-Linn. 1643.1

De piscibus, p. 413–484. Copy, U. T. S. Other eds.: Wittebergæ, 1616, 1624, 1633, 1642, 1649, 1659; Amstelodamæ, 1641, 1643, 1658, 1665; Lipsiæ, 1688; Francofurti, 1712 (5 vols.).

Frascatorius, *Hieronymus.* Liber I. De sympathia et antipathia rerum. Lugduni, 1550. Pre-Linn. 1550.1

Ship-holder, p. 24. Copy, C. P.

—— Opera omnia. Venetiæ. 1555. 4°. Pre-Linn. 1555.1

Another ed.: Venetiæ, 1584. 4°.

Freigius, *Johannes Thomas* [1543–1583] Quæstiones physicæ, in quibus methodus doctrinam physicam legitime docendi, describendique, rudi minerva descripta est libris XXXVI. Basel, 1579. 8°. Pre-Linn. 1579.1

"Horum liber XXXIII agit de piscibus & ichthyographia & ichthyographis."
Other eds.: Basel, 1582 & 1585.

Frey, *Heinr. Herm.* ICHTHYO-BIBLIA darinn die Fische, deren in der Bibel gedacht wird, sampt ihren Eigenschafften und abhangenden nützlichen Historien, beschrieben sind, etc. Leipzig, 1594. 66 p. woodcuts. 4°.
Pre-Linn. 1594.1

Jonah and the great fish, p. 30–49.

——THEROBIBLIA; Biblisch Thierbuch, darinnen alle vierfüssige, zahme, wilde, gifftige und kriechende Thier, Vogel und Fisch (deren in der Bibel meldung geschicht) etc. beschrieben sind. In drei unterschiedene Bücher abgetheilet, und mit schönen Figuren (in Holzschn.) gezieret. Leipzig, 1595, 383 p. 4°. Pre-Linn. 1595.1

"Biblisch Fischbuch," 1594, above is bound herein as section III without change of date. A copy of this rare old book in A. M. N. H.

Frézier, *Amédée Franç.* [1682–1773] Relation du voyage de la Mer du Sud aux côtes du Chili et du Perou, fait pendant les années 1712–14. Paris, 1716. 37 figs. 4°. Pre-Linn. 1716.1

English & Dutch versions are:

—— A voyage to the South Sea, and along the coasts of Chili and Peru in the

Frézier, *A. F.*
years 1712, 1713, 1714. London, 1717. 4°. Pre-Linn. 1717.1

Fishes, p. 8, 27, 82, 121. Plate of fishes (including Callorhynchus), to face p. 21.

—— Riis-beschryving door the Zuidzee langs de Kusten van Chili, Peru, en Brazil . . . in de j. 1712–14. Amsterdam, 1718. 4°. Pre-Linn. 1718.1

Other eds.: Amsterdam, 1717, 1727; Paris, 1717, 1732; Hamburg, 1718, 1749 (German); London, 1718. Also reprinted in Arkstee, & Merkus. "Allgemeine Historie der Reisen, etc." 1754–57, Bd. XII & XV, under title "Reise . . . durch die Strasse Le Maire, 1711–14."

Frisch, *Jodocus Leopold* [1714–1787] Musei Hoffmanniani petrefacta et lapides, oder Beschreibung der versteinerten Dinge und anderer raren Steine, welche in dem Kabinet . . . Fr. Hoffmann's befindlich. Halæ, 1741. x, 119 p. figs. 4°. Pre-Linn. 1741.1

Fossil fishes and sharks' teeth, p. 73, 76, 107. Reviewed in Leipzig. Gel. Zeitg., 1842, p. 54.

Frisch, *Joh.Leonhard* [1666–1743] De tæniis in piscibus. Misc. Berol., 1727, **3**, 43–44. fig. Pre-Linn. 1727.1

See also Frisch, J. L., Add., 1781.2.

—— Vestigia generationis tæniarum sive vermium latorum in piscibus et avibus, item de lubricis et tæniis in superficii hepatis et murium, etc. Misc. Berol., 1727, **3**, 44–46. fig. Pre-Linn. 1727.2

See also Frisch, J. L., Add. 1781.1.

—— De mustelæ fluviatilis [*Lota vulgaris*] et de tæniis in stomacho hujus piscis. Misc. Berol., 1734, **4**, 392–393. Pre-Linn. 1734.1

—— De tæniis in pisciculo aculeato, qui in Marchia Brandenburgica vocatur Stecherling. Misc. Berol., 1734, **4**, 395–396. Pre-Linn. 1734.2

See also Frisch, J. L. Add., 1781.4.

—— De Gobio capitato, Keuling, Kolbe, Kaulhaupt. Misc. Berol., 1740, **6**, 123. Pre-Linn. 1740.1

—— De ossibus dentatis in utraque pinna ventris carpionis. Misc. Berol., 1740, **6**, 122. Pre-Linn. 1740.2

—— De tæniis quæ in jecore piscium inveniuntur, imprimis vero in lucio pisce. Misc. Berol., 1740, **6**, 129. Pre-Linn. 1740.3

See also Frisch, J. L. Add., 1781.3.

—— Observationes ad lampetrarum tres species. Misc. Berol., 1740, **6**, 118–120. pl. Pre-Linn. 1740.4

"i. Ad vulgo oculatam sive septem spiraculis.
ii. Ad barbatam, Steinbeisser mit dem Bart.
iii. Ad aculeatam sive pangentem."

Fritsch, *Ahasuer.* Corpus juris venatorio-forestalis. 3 parts. Lipsiæ, 1702. fol. Pre-Linn. 1702.1

Part I includes Mor de Nigro Monte, George, Pre-Linn. 1602.1 (*q. v.*).

Froger, *François* [1676–1715] Relation d'un voyage fait en 1695–97 aux côtes d'Afrique, détroit de Magellan, Brésil, Cayenne & isles Antilles par une escadre des vaisseaux du roi, commandée par M. de Gennes, fait par le Sieur Froger. Paris, 1698. xii, 227 p. ills. 8°. Pre-Linn. 1698.1

"Pisces aliquos depictos paucisque verbis descriptos habet sub nominibus Bourse (Balestes) Porcepic de mer (Hystrix) Sucet (Echeneis neucrates)" — Walb.
Other eds. in French, Amsterdam, 1699 and 1715, are practically identical with the above. English and German versions are:

—— Voyage to Africa, Straight of Magellan, Cayenne, the Antilles, etc. London, 1698. 12°. Pre-Linn. 1698.2

—— Froger's Reise oder Nachricht von den Genes Reise nach der Magellanischen Strasse (In Arkstee & Merkus. Allgemeine Historie der Reisen, etc. 1754.) Pre-Linn. 1754.1

Fromman, *Johann Christian* (*præses*) Dissertatio de piscibus. Coburgi, 1679. 4°. Pre-Linn. 1679.1

Fischer, *respond.*

Frondius, *Elias* (*præses*) Disputatio de piscaturâ harengorum in Roslagiâ. Inaug. Dissert. Upsaliæ, 1745. 4°. Pre-Linn. 1745.1

Nils Humble, *respond.*

Fryer, *John* [–1733] A new account of East India and Persia in eight letters, being nine years travels, begun 1672, and finished 1681. London, 1698. ills. fol. Pre-Linn. 1698.1

For fishes, *see* indices and marginal references. Abstract in Phil. Trans. Roy. Soc., 1698, **20**, 338–348.

Füessli, *Joh. Melchior.* Eigentliche Abbildung aller in dem Zürich-See und der Limmat sich befindenden Gattung Fischen, in welchen Monaten selbige, wie hier verzeichnet, wegen des Laiches und Fasels zu fangen, zu kaufen und zu verkaufen verboten sind. Zürich, 1709. Pre-Linn. 1709.1

Listed also under Stiefeinus, J. M., by H. Fischer-Sigwart in "Poissons," Fauna Helvetica, cahier 5; Bibliographie Nationale Suisse, 1900, fasc. IV 6, p. 52.

Funnell, *William.* A voyage around the world, containing an account of Captain Dampier's expedition into the South Seas . . . in the years 1703 and 1704, etc. London, 1707. 8°.
Pre-Linn. 1707.1

A number of fishes are poorly figured and poorly described.
Another ed. is:

—— A voyage round the world, being an account of W. Dampier's expedition into the South Seas (1703–1706). (In "A collection of voyages." 4 vols. London, 1729, vol. IV. 208 p. pls. 8°.)
Pre-Linn. 1729.1

G

G., *C.* The secrets of angling; imparting the best and choicest experiments for taking all sorts of fish, with fly, worm, paste and other baits; also to know their haunts and how to angle for them in all waters and weathers. By C. G. a brother of the angle. London, 1705. 24 p. 16°.
Pre-Linn. 1705.1

Galenus, *Claudius* [130–200] Opera medica [Edited by Diomedes Bonardus and L. Malatinus]. Venice, 1490. fol.
Pre-Linn. 1490.1

This seems to be the 1st ed. of Galen's works. Another is:

—— Opera omnia, ad fidem complurium et perquam vetustorum exemplariorum . . . emendata atque restituta [by H. Gemusæus, L. Fuchsius and J. Camerarius]. 5 parts [in 4 vols.] Basiliæ, 1538. fol. Pre-Linn. 1538.1

In his "De alimentorum medicinalia," vol. III, chaps. 24–31, Galen speaks of a large number of fish relative to the qualities of their flesh as food. The "De alimentorum" was separately published as:

—— De alimentorum facultatibus Libri III. Ex Martini Gregorii interpretatione pluribus in locis, hac aditione emendata. Lugduni Batavorum [Leyden], 1633. 24°.
Pre-Linn. 1633.1

One of the earliest commentaries on the names of fishes mentioned by Galen, Dioscorides and other ancient writers on medicine and natural history is that by Charles Estienne, published at Paris in 1536. *See* Estienne, C., 1536.1.

For a modern commentary on the fishes mentioned by Galen and Xenocrates, *see* Koraes, A., 1809.1.

Gamon, *Christophle de* [1576–1621] Les pescheries de Christophle de Gamon, divisées en deux parties. Où sont contenus, par un nouveau genre d'escrire, et sous des aussi beaux que divers enseignemens, les plaisirs inconnus de la mer, et de l'eau douce. Lyon, 1599. 142 leaves. 12°. Pre-Linn. 1599.1

Gardiner, *Samuel.* A booke of angling, or fishing, wherein is shewed, by conference with scriptures, the agreement betweene the fishermen, fishes, fishing of both natures, temporall and spirituall, etc. London, 1606. 162 p. 16°. Pre-Linn. 1606.1

"Fishing spiritualized."

Garsin, *Laurent.* Description d'une sangsue de mer (*Hirudinella marina*) trouvée dans l'estomac d'une bonite. Mém. Acad. Sci. Paris, 1730, hist., 43. — Phil. Trans. Roy. Soc., 1730, 387.
Pre-Linn. 1730.1

Gauchet, *Claude Dampmartinois.* (*Aumonier du Ruy.*) Le plaisir des champs, devisé en quatre parties selon les quatre saisons de l'année; où est traité de la chasse et de tout autre exercise recréatif, honeste et vertueux. Paris, 1583. 4°. Pre-Linn. 1583.1

Contains a chapter, "La pescherie."
Another ed.: Paris, 1604.

Gautier d'Agoty, *Jacques Ant.* Observations sur la physique, l'histoire naturelle et la peinture. 6 vols. 1752–1755. Pre-Linn. 1752.1

The author reproduced in this work a number of Plumier's paintings of West Indian fishes not elsewhere published.

—— Collection de [45] planches d'histoire naturelle en couleur, d'après les animaux, les plantes & les mineraux les plus rares &c. Paris, 1757. 4°.
Pre-Linn. 1757.1

The viscera of the Dorado, pls. 40 & 41.
These plates, like the above, are probably Plumier's.

Gaza, *Theodorus* [c. 1400–1475] A native of Thessalonica, the capture of his native city by the Turks in 1430 drove him to Italy where he became professor of Greek in the University of Ferrara in 1447. From 1450–1455, he lived in Rome and under the patronage of Pope Nicholas V translated Aristotle, Theophrastus, and other Greek authors into Latin. *See* reference to him under Aristotle.

Geer, *Carl de* [1720–1778] [On reproduction in the eel] K. Svensk. Vet. Acad. Handl., 1750, **11,** 196–197. — König. Schwed. Akad. Abhand., 1750 (1754), **12,** 201–202.
Pre-Linn. 1750.1

Gentleman of Elvas (*The*). *See* **Fidalgo de Elvas.**

Geoffroy, *Claude Joseph* [1685–1752] Description d'un tenia trouvé dans une tanche fort saine. Mém. Acad. Sci. Paris, 1710, hist., 39.
Pre-Linn. 1710.1

—— Observation sur soixante-six petits poissons, sortis vivans par une membrane rompue d'un poisson qu'on croit être le Galeus piscis. Mém. Acad. Sci. Paris, 1719 (1721), hist., 40.
Pre-Linn. 1721.1

—— Suite de l'examen chimique des chairs des animaux, ou de quelques-unes de leurs parties, etc. Mém. Acad. Sci. Paris, 1732 (1735), 17–30.
Pre-Linn. 1735.1

Flesh of carp and pike analyzed.

—— Observation sur les dents de lamie ou Carcharias. Mém. Acad. Sci. Paris, 1741, hist., 34.
Pre-Linn. 1741.1

Geoffroy, *Etienne François.* Premier mémoire sur l'organe de l'ouïe des reptiles, et de quelques poissons que l'on doit rapporter aux reptiles. Mém. Math. Phys. Scavans et Etrangers, Paris, 1755, **2**, 164–196. 3 pls. — Uitgez. Verh., 1760, **5**, 297–350.
Pre-Linn. 1755.1

This title replaces the citation credited to Geoffroy-Saint-Hilaire, Etienne François [who should be designated Etienne] 1786.1, which is erroneous.

Gerald de Barri. *See* **Giraldus Cambrensis.**

Gerbezius, *Marc.* Piscium copia sterilitatis prænuncia. Eph. Nat. Cur., 1694, dec. 3, an. 1, 226.
Pre-Linn. 1694.1

Gering, *Johann Gabriel* (*respond.*) Dissertatio medico-physica de piscibus. . . . submittit alumnus regius . . . Upsaliæ, 1727. 26 p.
Pre-Linn. 1727.1

L. Roberg, *præses*.
Anatomy described for Lampetra, Anguilla, Silurus, Acus, Asellus, Salmo, Spirinchus, and Albula.

Germain, *J.* Breve ę sustatiale trattato intorno alle figure anatomiche delli piu animali terrestri aquatili e volatili. Neapoli, 1625. fol.
Pre-Linn. 1625.1

Not seen. Title from Haller. Probably the same as Germano, F. G. (*q. v.*).

Germano, *F. Girol.* Figure anatomiche delle più principali animali terrestri, aquatili e volatili, colla simpathia e convenienza che hanno, o in parte, o in tutto, con il corpo umano. Napoli, 1625. fig. fol.
Pre-Linn. 1625.1

Title from Agassiz and Boehmer. *See* also Germain, J., above.

Gesner, *Conrad* [1516–1565] For life of the man whom Cuvier designated as " le plus savant naturaliste du seizième siècle," *see* the contemporary biography by J. Simler, Zurich, 1566; also by J. Hanhart, Winterthur, 1824; also Lebert's " Gesner als Arzt," Zurich, 1854. More accessible is C. H. Smith's memoir in Jardine's Naturalist's Library, vol. XXXI, 1834–43 issue; vol. XX of 1845–46 edition. *See* also Brooks, W. K. 1895.1. For shorter sketches, *see* Locy, W. A., 1908.1; and Miall, L. C., 1912.1.

Gesner's great natural history, " Historia animalium," was published in Zurich in 5 parts, 1551–87. fol. It comprises a total of about 4,500 folio pages, and is illustrated by hundreds of woodcuts. The various parts of the history were often reprinted in full or in abridged form and were frequently translated. A complete second edition was issued at Frankfort, 1617–20.

For title of part IIII, " De piscium," etc., and for reprints and editions of this, *see* below.

—— De piscibus et aquatilibus omnibus libelli III novi. I. Scholia et emendationes in Halieuticon P. Ovidii Nasonis. II. Aquatilium animantium enumeratio juxta Plinium, emendata et explicata, serie literarum. III. Eorundem nomenclator Germanicus longe copiossissimus. Et alia quædam ad piscium historiam pertinentia. Tiguri, 1556. vi, 280 p. 18 pls. 8°.
Pre-Linn. 1556.1

Not seen. Title so reads in Walbaum, Gronow, and Carus & Engelmann. Two other variants are given (the first from Agassiz).

Ovidii Halieuticon, hoc est de piscibus libellus, multo quam ante hac emendatior et scholiis illustratus. Accedit aquatilium animantium enumeratio juxta Plinium, etc. Tiguriæ, 1556. iv, 280 p. 8°.

P. Ovidis Nasonis, de piscibus libellus, multo quam ante hac emendatior & scholijs illustratus; emendatur Plinii aliquot loca; accedit aquatilium animantium enumeratio iuxta Plinium, emendata & explicata per Conradum Gesnerum, ordine alphabetico; eorundem nomina Germanica, eodem ordine. Tiguri, [1556]. vi, 280 p.

According to Westwood & Satchell, this compilation is appended to an edition of Ovid's "Halieuticon." The running title is, "Tütsche

Gesner, *C.*

Namen der Fischen und Wasserthieren." An extremely valuable list. In it the fish called "Killinck" in the early Flemish "Boeckxen" is identified as the gudgeon. Some English names are included.

—— Historiæ animalium liber IIII, qui est de piscium & aquatilium animantium natura . . . Tiguri, 1558. 1297 p. figs.
Pre-Linn. 1558.1

This work forms book IIII of the "Historiæ animalium." Other eds.: Frankfort, 1604 & 1620; & Heidelberg, 1606; 1712.

—— Nomenclator aquatilium animantium. Icones animalium aquatilium in mari & dulcibus aquis degentium, plus quam DCC. cum nomenclaturis singulorum Latinis, Græcis, Italicis, Hispanicis, Gallicis, Germanicis, Anglicis, aliisque; interdum per certos ordines digestæ. Explicantur autem singulorum nomina ac nominum rationes, præcertim in Latina et Græca lingua uberrimè; et nominum confirmandorum causa descriptiones quorundam, et alia quædam, præsertim in magno nostro De aquatilibus volumine non tradita, adduntur: deque singulis Rondeletii, Bellonii, Salviani et nostræ sententiæ explicantur brevissime . . . Tiguri [Zurich], 1560. xiv, 374 p. woodcuts. fol. Pre-Linn. 1560.1

In this work, usually cited as "Icones animalium aquatilium," the text is much reduced from that of the "Historiæ animalium," liber IIII, 1558, but the woodcuts are with few exceptions the same.

First ed.; another, Heidelberg, 1606.

—— Fischbuch, das ist ein kurtze doch vollkomne Beschreybung aller Fischen so in dem Meer unnd süssen Wasseren, Seen, Flüssen oder anderen Bächen jr Wonung habend, sampt jrer waaren Conterfactur: zü Nutz und Gütem allen Artzeten etc. gestelt, insonders aber denen so ein Lust habend zü erfaren und betrachten Gottes wunderbare Werck in seinem Geschöpften. Erstlich in Latein durch Cünradt Gässner beschriben yetz neüwlich aber durch Cünradt Forer etc. in das Teütsch gebracht. Zürych, 1563. ix, 404 p. woodcuts. fol. Pre-Linn. 1563.1

First ed. of Forer's version of the "De piscium." Others are: Zurich, 1563 (a separate issue) & 1575; Frankfort, 1598; & Heidelberg, 1606. However, entirely apart from these are the versions immediately following the next title.

—— De rerum fossilium, lapidum et gemmarum maxime . . . liber, &c. Tiguri, 1565. xiv, 169 p. (In Gesner, C. (editor). De omne rerum fossilium genere, gemmis, lapidibus, metallis et hujus-modi, libri aliquot, &c. Tiguri, 1565–(66). 8°.) Pre-Linn. 1565.1

This volume contains the works of 7 other authors.

—— Thier-, Vogel-, Fisch- und Schlangenbuch [8 parts] Zürich, 1575–89. woodcuts. fol. Pre-Linn. 1575.1

—— L'histoire des animaux à quatre pieds, des oiseaux, des poissons, . . . de Gesner. Paris, 1619. figs. fol.
Pre-Linn. 1619.1

Gesner, *Johann Matthias* (*editor*) [1691–1761] Scriptores rei rusticæ veteris Latini. . . et lexicon rei rusticæ curante J. M. Gesner. 2 vols. Lipsiæ, 1735. 4°. Pre-Linn. 1735.1

Here are collected the "De re rustica" of various authors elsewhere referred to. The works of these "old farmers," as D. G. Mitchell calls them, have references to fish and fishponds. Another and the most celebrated edition is that of 1787, the contents of which are:

Vol. I. [Preface by Gesner and lives of the several authors, &c.].

M. P. Catonis de re rustica.

M. T. Varronis de re rustica libri III.

Vol. II. L. J. M. Columellæ de re rustica libri XII, et de arboribus.

Vol. III. Palladii Rutilii Tauri Aemiliani de re rustica libri XIV. Vetetii renati artis veterinariæ liber IV. A. Popmæ Frisi de instrumento fundi liber.

Vol. IV. Lexicon rusticum.

—— Tractatus physicus de petrificatis, etc. Lugduni Batavorum, 1758. 8°.
Pre-Linn. 1758.1

Fossil sharks' teeth, p. 61.

Geyer, *Johannes Daniël* [1660–1735] Targelus Apollini facer continens trigam medicam e regno animali & vegetabili: I. De cantharidibus. II. De montibus conchiferis & glossopetris Alzeiensibus archipalatinis. III. De dictamno. Lipsiæ, 1687. figs. 4°. Pre-Linn. 1687.1

"De glossopetris" [fossil sharks' teeth] found also in Valentini, M. B. "Historia litteraria . . . Academiæ Naturæ Curiosorum, etc." Gissæ, Hassorum, 1708.

—— Müssiger Reise-Stunden gute Gedancken von denen Brsczenischen Carthausern der Litthauischen Carthaus Paradis, und der Ichthiophagia quadragesimali. 17. Discours. Dresden, 1735. 4°. Pre-Linn. 1735.1

Giannettasius, *Nic. Parthenius.* Piscatoria et nautica. Napoli, 1685. 8°. Pre-Linn. 1685.1

Other eds.: Napoli, 1686, 1692.

—— Halieutica. Napoli, 1686. 8°.
Pre-Linn. 1686.1

Other eds.: Napoli, 1689, 1696.

Both included in an ed., Naples, 1710–22.

Gilbert, *William.* The angler's delight, containing the whole art of neat and clean angling; wherein is taught the readiest way to take all sorts of fish, from the pike to the minnow, together with their proper baits, haunts, and time of fishing for them, whether in mere, pond, or river, etc. London, 1676. 45 p. 12°. Pre-Linn. 1676.1

—— The young angler's companion. Containing the whole art of neat and clean angling . . . The like never before in print. London, 1682. 45 p. 12°. Pre-Linn. 1682.1

Reprinted, London, 1776. Copy, 1682 ed., N. Y. P.

Gilles, *or* **Gylles** (Lat. **Gillius**), *Pierre* [1490–1555] For a biographical notice and analysis of his books, *see* Hamy, E. T. in Nouv. Arch. Mus. Hist. Nat. Paris, 1900, 4. sér. **2**, 1–24.

—— Ex Aeliani historia per Petrum Gyllium Latini facti, itemque ex Porphyrio, Heliodoro, Oppiano, tum eodem Gyllio loculentis accessionibus aucti libri XVI. De vi et natura animalium; ejusdem Gyllii liber unus, de gallicis et latinis nominibus piscium. Lugduni [Gallorum], 1535. 599 p. 4°. Pre-Linn. 1535.1

—— De nominibus gallicis et latinis piscium massiliensium. Lyon, 1535. Pre-Linn. 1535.2

This, which in the copy examined, is added as a sort of preface to the preceding, seems to have been in MS. as early as 1533. It contains the common names, ancient and contemporary, of 93 Mediterranean fishes.

A naturalist and traveller, Gilles examined the fishes of the Mediterranean and Adriatic; he also published Aelian in Latin, rearranging his matter, and identifying the species where possible. By some he has been called "le père de la zoologie française."

Gillmore, *J.*, & **Steele** (*Sir*) *R.* *See* **Steele & Gillmore.**

Gimma, *Giacinto.* Della storia naturele delle gemme, delle pietre, e di tutti i minerali, ouvero della fisica sotterranea. 2 vols. Naples, 1730. 551, 603 p. 4°. Pre-Linn. 1730.1

Vol. I, book IV, p. 433. Lapides piscium.
Vol. II, book I, p. 1 Glossopetra.

Giovio, (Lat. **Jovius**), *Benedetto* [1472–1544] De Laris lacu et ejus piscibus carmen. Romæ, 1524. fol. Pre-Linn. 1524.1

This poem on the fishes of lake Como is also found in the 1561 and 1578 editions of the collected works of Paolo Giovio, his brother. Also in "Thesaurus antiquitatum et historiarum Italiæ." Lugduni Batavorum, 1704.

Giovio, *or* **Jovius,** *Paolo* [1483–1552] For biographical sketches, *see* Müntz, Eug. in Arch. Stor. Ital., 5. ser. **19**; and Sanesi, Guiseppe. *Ibid.*, **23**; also Encyclopædia Britannica, 11. ed. 1911, vol. XV, 526–527.

—— De romanis piscibus libellus; . . . accedunt antiqua et recentiorum nomina piscium marinorum, lacustrium et fluviatilium, quæ in Jovii commenttariis continentur. Romæ, 1524. fol. Pre-Linn. 1524.1

The 1st ed.; another, Basel, 1526.

—— Liber de piscibus marinis, lacustribus, fluviatilibus, item de testaceis et salsamentis. Romæ, 1527. 4°. Pre-Linn. 1527.1

This work treats of the river, lake and marine fishes (especially Adriatic) of Italy. It passed through many eds.: Basel, 1531, 1545, 1571; Rome, 1554, 1560, 1584; Antwerp, 1528; Strasburg, 1534 (Copy, A. M. N. H.); Paris, 1649; Venice, 1731. An Italian version is entitled:

—— Libro di. Mons. Paolo Giovio de' pesci Romani, tradotto in volgare da carlo Zancaruolo . . . Venetia, 1560. 198 p. 8°. Pre-Linn. 1560.1

—— Descriptio Larii lacus. Basileæ, 1561. fol. Pre-Linn. 1561.1

Also found in "Thesaurus antiquitatum et historiarum Italiæ." Lugduni Batavorum, 1704, vol. III.

—— Opera. Basel, 1578. Pre-Linn. 1578.1

The best ed.; an earlier, Basel, 1561.

Giraldus Cambrensis *or* **Gerald de Barri** [1146–1220] Topographia Hibernica. (Published with Holinshed's Chronicle, 1587. fol.) Pre-Linn. 1587.1

Pisces marini, cap. IX.
This work, written *c.* 1186, remained in MS. until published in 1587. For a modern edition of the works of Giraldus, *see* that in 8 vols. edited by J. S. Brewer, J. F. Dimock, & G. F. Warner, London, 1861–91.

Gissler, *Nils* [1715–1771] Beschreibung eines Fisches, Tänglake [*Blennius viviparus*] König. Schwed. Akad. Abhandl., 1748, **10**, 39–45. Pre-Linn. 1748.1

See note under Kästner, A. G., this section.

—— Beschreibung des Fisches Strömming in Nord-Bothnien. König. Schwed. Akad. Abhandl., 1748, 109–141. Pre-Linn. 1748.2

See note under Kästner, A. G.

—— Beskrifning om strömmings fiskets beskaffenhet i Norrbotten. K.

Gissler, *N.* Swensk. Vetensk. Akad. Handl., 1748, **10**, 107–140. Pre-Linn. 1748.3

—— På tånglaken. K. Swensk. Vetensk. Akad. Handl., 1748, **10**, 37–44. Pre-Linn. 1748.4

See also Analect. Transalp., 1762, **1**, 485–489. (Gissler, N., [n. d.] in vol. I.)

—— Nachrichten von der Natur und Fischerey des Lachses in den Nordländischen Elben. König. Schwed. Akad. Abhandl., 1751, **13**, 12–31; 99–133; 177–196; 275–290; *Ibid.*, 1752, **14**, 16–28; 87–99. Pre-Linn. 1751.1

See note under Kästner, A. G.

—— Rön om laxens natur och fiskande i de Norrländska alfvarna. K. Swensk. Vetensk. Acad. Handl., 1751, **11**, 95; 171; 268. *Ibid.*, 1752, **11**, 93. Pre-Linn. 1751.2

—— Anmärkningar om sik-fisket uti Norrländska Älfver [Coregonus] och skärgärdar. K. Swensk. Vetensk. Acad. Handl., 1753, **13**, 195–209. Pre-Linn. 1753.1

Glanville, *Bartholomœus.* *See* **Bartholomæus Anglicus.**

Gleditsch, *Johann Gottlieb* [1714–1786] De fertilitate piscium. Conf. Neue Anmerk. über alle Theile der Naturlehre, Kopenhagen, 1756, **3**, 568. Pre-Linn. 1756.1

—— De propagatione piscium. Physikal. Oekon. Patriot, Hamburg, 1756, pt. I, 295. Pre-Linn. 1756.2

—— Betrachtung über die Reichthümer Gottes in dem Wasser, (ubi præcipue de stupenda copia et fertilitate piscium agitur.) Reich Natur u. Sitten, 1757, **1**, 289. Pre-Linn. 1757.1

Glorez, *Andr.* Haus- und Land-Bibliotheck. Regiomonti, 1700. fol. Pre-Linn. 1700.1

Tome I, liber XIII, von der Fischerey, p. 393–409.

Glover, *Thomas.* An account of Virginia, its scituation, temperature, productions, inhabitants . . . &c. Phil. Trans. Roy. Soc., 1676, **11**, 623–636. Pre-Linn. 1676.1

References to fishes of Virginia, p. 624–625.

Glovez, *Andreas.* Vollständige Haus- und Landbibliothek, Jagd, Vogelfang, Fischerei, etc. Nürnberg, 1719. fol. Pre-Linn. 1719.1

"Von der Fischerei," p. 393–409.

Göchhausen, *Herm. Frid. von.* Notabilia venatoris; oder Jagd- und Weidwerksanmerkungen. Nordhausen, 1710. 2 pl. fol. Pre-Linn. 1710.1

Other eds.: 1718; 1727; 1737; 1722; 1731; 1740; 1751; 1764.

A writer in the Gel. Nachricht zum Hamburg Corresp., 1751, says that the 5th ed. contains a description of various streams and fishes.

Göritzius, *Johann Adam.* Von den frembden Fischen, Seelauben (Alosa) genannt. Bresl. Natur. Kunstgesch., 1721, 17. sec., 168. Pre-Linn. 1721.1

Götz, *Frid. Leberecht.* Dissertatio de ICHTHYOLAPREIA. Lipsiæ, 1723. 4°. Pre-Linn. 1723.1

Gomara, *Francisco Lopez de* [1510–1560 *or* 1576] La historia general de las Indias, con todos los descubrimientos, y cosas notables que han acaescido enellas, dende que se ganeron hasta agora, escrita por Francisco Lopez de Gomaro, clerigo Añadiose de nuevo la descripcion y traca de las Indias, . . . Anvers, 1554. 16 leaves, 287 p. sm. 8°. Pre-Linn. 1554.1

A number of contemporary Spanish editions were issued, and the book was reprinted in Spain several times during the 19th century.

There are French versions of 1568, 1584, 1587, and 1606, and an English translation of 1578. Available are:

—— Histoire générale des Indes occidentales, etc. Paris, 1568. 8°. Pre-Linn. 1568.1

—— The pleasant historie of the conquest of the Weast India [T. Nicholas trans.] London, 1578. 4°. Pre-Linn. 1578.1

Gomara records data concerning West Indian fishes and gives an account of fishing with the remora. He never visited the new world.

Googe, *Barnaby* (*editor*) [1540–1594] *See* note under **Heresbach,** *C.*, Pre-Linn., 1577.1.

Gosky, *Mart.* Arbustum Augusteum. Wolffenbüttel, 1650. figs. Pre-Linn. 1650.1

Die Fische im Herzogthum Braunschweig, p. 280 —.

Grandi, *Lazaro.* Alfabetto di secreti medicinali . . . con l'arte facile d'uccallare, e pescare. Bologna, 1667. 216 p. 8°. Pre-Linn. 1667.1

Grant, *W.* Auszug aus — Brief — von der Paarung und Fortpflanzung des Lachses. König. Schwed. Acad. Abhandl., 1752, 142–146. — Uitgez. Verh., **4**, 236–241. Pre-Linn. 1752.1

See note under Kästner, A. G., this section. *See* also Grant, W. Add. 1762.1.

—— Utdrag af — bref — om laxens parnings och afelses sätt. K. Swensk. Vetensk. Acad. Handl., 1752, 134–138. Pre-Linn. 1752.2

Grapaldus, *Francis Marius* [1464–1515] De partibus ædum, etc. 1494. Pre-Linn. 1494.1

See Lambert, Osmund, 1883.1, for a notice of this work.

Grausius, *M.* Beschryvinge van de natur der viervoetige dieren, vissen en water-dieren, vogeln etc. nessen haer beeldnissen in kopper gesneden uyt et latin vertaelt. Amsterdam, 1660. fol. Pre-Linn. 1660.1

Grew, *Nehemiah* [1641–1712] Museum Regalis Societatis, Or a catalogue & description of the natural and artificial rarities belonging to the Royal Society and preserved at Gresham Colledge . . . Whereunto is subjoyned the comparative anatomy of stomachs and guts. London, 1681. 386, 42 p. 31 pls. 4°. Pre-Linn. 1681.1

Of viviparous fishes, sect. i, chap. I, p. 81–103. The plates are well executed and 7 non-European fishes are described.
A 2nd ed.: 1686.

Griffiths, *Roger,* (*Water-Bailiff*). An essay to prove that the jurisdiction and conservancy of the River of Thames . . . is committed to the Lord Mayor and City of London, both in point of right and usage, by prescription, charters, etc. To which is added a brief description of those fish with their seasons, etc., that are caught in the Thames or sold in London. With some few observations on . . . fish in general. London. 1746. xx, 296 p. 8°. Pre-Linn. 1746.1

"This work appears to have been an appurtenance of the water-bailiffs, as in 1758 we find it claimed by Robert Binnell." (*q. v.*) — W. & S.
Copy, N. Y. P.

Grindal, *William.* Hawking, hunting, fouling, and fishing, with the true measures of blowing. Now newly collected by W(illiam) G(ryndall). London, 1596. 4°. Pre-Linn. 1596.1

A black letter reprint, or plagiarized edition, of the "Boke of St. Albans."

Gronovius, *Johannes Fridericus* [1690–1760] Descriptio Cottus, ossiculo pinnæ dorsalis primo longitudine corporis, descriptus. Acta Reg. Soc. Sci. Upsal. 1740, 121–123. pl. 8°. Pre-Linn. 1740.1

Identified as *Callionymus lyra.*

—— Pisces Belgii, seu piscium in Belgio natantium et a se observatorum catalogus. Acta Reg. Soc. Sci. Upsal., 1741, 67–76. — Uitgez. Verh., 1757, **1**, 145–159; 324–332. — Act. Helvet.,1760. (in Latin). Pre-Linn. 1741.1

—— *Salmo oblongus,* maxillæ inferioris apice introrsum reflexo descriptus. Acta Reg. Soc. Sci. Upsal., 1741, 85–90. Pre-Linn. 1741.2

—— A method of preparing specimens of fish by drying their skins. Phil. Trans. Roy. Soc. London, 1742, **42**, 57–58. — Beyträg. Naturgesch. Mineralreiches, **1.** — Nachr. Schles. Oekon. Ges., **4**, 321. Pre-Linn. 1742.1

—— Pisces Belgii rariores descripti. Acta Reg. Soc. Sci. Upsal., 1742, 79–107. pls. Pre-Linn. 1742.2

Cobitis (*Mustela fossilis*), Scomber, Gadus (*Asellus virescens*), Gadus (alius), Blennius, (*Mustela vivipara*), Trachinus, Trigla.

—— Piscis Scombri et Percæ descriptio. Acta Reg. Soc. Sci. Upsal., 1744, 36–42. pl. Pre-Linn. 1744.1

—— The figure of the *Mustela fossilis* [*Cobitis cœrulescens*]. Phil. Trans. Roy. Soc. London, 1747 (1748), **44**, 451. fig. Pre-Linn. 1748.1

Gronovius, *Laurentius Theodorus* [1730–1778] Museum Ichthyologicum, sistens piscium indigenorum et quorundam exoticorum, qui in Museo Laur. Theod. Gronovii, adservantur, descriptiones, ordine systematico; accedunt nonnullorum exoticorum piscium icones, æri incisæ. 2 vols. Lugduni, 1754–56. 70, 46 p. 25 pls. fol. Pre-Linn. 1754.1

Vol. I (1754) contains the fishes.

—— Beschryving van een onbekende inlansen vis Cyclogaster [Cyclopterus]. Uitgez. Verh., 1757, **1**, 581. 2 figs. Pre-Linn. 1757.1

—— Lijst van eenige vissen van Nederland, die door den Heere J. F. Gronovius in de Acta Upsaliensia van't jaar 1741 niet angetekend zijn. Uitgez. Verh., 1757, **1**, 324–332. Pre-Linn. 1757.2

For later works of this author, *see* Gronovius, L. T. in vol. I.

Gronow. *See* **Gronovius.**

Grundig, *C.G.* Neue Versuche nützlicher Sammlungen zur der Natur- und Kunstgeschichte, sonderlich von Ober-

Grundig, *C. G.* sachsen. 4 vols. Schneeberg, 1750–65. 8°. Pre-Linn. 1750.1

Gründlicher Bericht von der Zucht, Versetzung und Wartung der Karpfen.
Fossil fishes, vol. I, p. 463, 567.

Guenelloni, ——. Excerpta ex epistola ad Charletonu, anatomian oculi [Gadus] concernentia. Nouv. Reipub. Litt. Amstelodami, 1686, **8**. fig. — Act. Erudit, [1686], **5**, 139. Pre-Linn. 1686.1

Guicciardini, *Luigi* [1523–1589] Belgium, dat is: Nederlandt, ofte beschryvinge derselviger provincien ende steden. Amstelodami, 1648. figs. maps. fol. Pre-Linn. 1648.1

"Visschen van de Mase, p. 13; van de Schelde, p. 14. Haringhen, cabeljau, salmen, steuren, p. 20–21. Grousame visschen, p. 264." — Bosgoed.
Other eds.: 1st., Antwerp, 1567 (in French & Italian); 1580 & 1588 (both in Dutch); Basel, 1580 (German); & Amsterdam, 1613 (Latin).

Gumilla, *Joseph* [c. 1690–1758] El Orinoco ilustrado, y defendido, historia natural, civil, y geographica de este gran rio, y de sus caudolosas vertientes: . . . con nuevas, y utiles noticias de animales, arboles, fiutos aceytes, refinas, yervas, y raices medicinales; . . . &c. 2 vols. Madrid, 1741. 24, 403 p. pl. map. 4°. Pre-Linn. 1741.1

"Variedad de peces, y singulares industrias de los Indios para pescar: Piedras y buessos medicinales, que se han descubierto en algunos pescados," — tome II, cap. xxi, p. 314–330.
The 1st ed.; 2nd (title unchanged), Madrid, 1745. A French version of the latter is entitled:

—— Histoire naturelle, civile et géographique de l'Orénoque. . . . Dans laquelle on traite . . . des animaux, des arbres des fruits, des résines, des herbes & des racines médicinales qui naissent dans le pais . . . &c. 3 vols. Avignon & Marseilles, 1758. 383, 334, 332 p. pls. map. 12°. Pre-Linn. 1758.1

"Poissons de l'Orénoque. Moyens industrieux dónt les Indiens se servent pour les prendre. Vertus médicinales des pierres & des os qu'on trouve dans quelques uns," — tome II, chap. xxi, pp. 36–58.
A later Spanish edition has the following title:

Historia natural, civil y geografica de las naciones situadas en las riveras del Rio Orinoco. Su autor el Padre Joseph Gumilla, . . . Nueva impresion: Mucho mas correcta que las anteriores, y adornada con ocho láminas finas, . . . Corregido por el P. Ignacio Obregón, de las Clérigos Menores: 2 vols. Barcelona, 1791.
Variedad de peces, y singulares industrias de los Indios para pescar, vol. I, p. 277–292. Peces ponzoñosos y sangrientos, vol. II, p. 204–214.

A present day reprint is said to have been issued Barcelona, 1882, but has not been seen.

Guyot, ——, & **Pajot,** ——. [On a method of preserving fishes in their natural colors]. Mercure de France, 1749. Pre-Linn. 1749.1

Gyllius, *Petrus*. *See* **Gilles,** *Pierre*.

H

H., *R.* The school of recreation: or the gentlemans tutor to those most ingenious exercises of hunting, racing, hawking, . . . fishing, etc. London, 1684. 202 p. 12°. Pre-Linn. 1684.1

Sometimes (doubtfully) attributed to R. Howlett.

Often reprinted: London, 1696, 1701 (a paginary reprint), 1710, 1719, 1720, 1732, 1736, 1784.

Haecken, *Arnold van.* Eight plates from pictures in Fishmonger's Hall in London, containing the fish brought to the London market. Painted from the life by A. van Haecken, engraved by G. King and A. Jongelincx. London, 1734. fol. Pre-Linn. 1734.1

Another edition, having a frontispiece recording "The view and humors of Billingsgate," appeared in 1736.

Hagen, *J. L.* Landwirthschaftliche Teich- und Weiherlust, oder gründliche Information zur edlen Fischerei. Frankfurt, 1727. 8°. Pre-Linn. 1727.1

Hahn, *Justinius.* Conclusiones juridicæ de jure colonario si perpetuæ coloniæ piscandi, venandi, aucupandi. Helmstadtii, 1678. 4°. Pre-Linn. 1678.1

Hain, *John Paterson.* De cochlea in capite lucii reperta. Ephemer. Acad. Nat. Cur., 1671, dec. 1, ann. 2, obs. **115**, p. 192. Pre-Linn. 1671.1

Hale, *Thomas* (*editor*) A compleat body of husbandry, containing rules for performing in the most profitable manner the whole business of the farmer and country gentleman . . . London, 1756. iv, 719 p. illust. fol. Pre-Linn. 1756.1

Chapters XLII–XLV in book V, vol. II, of this ed., making and stocking fish-ponds, feeding, preserving, and rearing fish.

2nd ed., 4 vols. London, 1758. (*See* Hale, T. 1758.1)

Hales, *Stephen* [1677–1761] An account of some trials to keep water and fish sweet with lime-water. Phil. Trans. Roy. Soc. London, 1753–54 (1754), **48**, 826–831. — Wittenberg. Wochenbl. 1770, 102. Pre-Linn. 1754.1

Haller, *Albrecht von* [1708–1777] For memoir with portrait, *see* Swainson, W. (In Jardine, Sir William The Naturalist's Library. 1862, vol. XIII.)

—— Auszug aus einem Schreiben Herrn Grants von der Paarung und Fortpflanzung des Lachses. König. Schwed. Akad. Abhandl., 1752, **14**. Pre-Linn. 1752.1

See note under Kästner, A. G.

—— Om laxens parnings- och aflelsessätt. K. Svensk. Vetensk. Akad. Handl., 1752, 134. Pre-Linn. 1752.2

—— Observation sur le pénis des saumons. Mém. Acad. Sci. Paris, 1753, hist., 136–137. Pre-Linn. 1753.1

For later works of this author, *see* Haller, Albert von, in vol. I.

Hamberger, *Georg Erhard* [1697–1755] Programma 1. 2. 3. 4. 5. de Cyprino monstroso rostrata. Jenæ, 1748. 8 p. pl. 4°. Pre-Linn. 1748.1

Hannaeus, *George. Xiphias adumbratus.* Ephemer. Acad. Nat. Cur., 1689 (1690), dec. 2, an. 8, observ. 107, 241–243. Pre-Linn. 1690.1

Hannemann, *Bartholomæus Johann Otto.* De passere pisce grandinoso [Goldbutten]. Misc. Acad. Nat. Cur., 1697, 3. dec. **5**. *Ibid.*, 1698, **6**, 462. Pre-Linn. 1698.1

Hannemann, *Johann Ludwig* (*præses*) [1640–1724] Dissertatio de pisce torpedine ejusque proprietatibus admirandis exhibens. Inaug. Dissert. Kiloni, 1710. 18 p. 4°. Pre-Linn. 1710.1

Abia Georg Cramer, *respond.*

Hannemann, *Peter Johann Chstn. Friederich.* De articulatione ossium singulari in spina piscis Americani, cujus ginglymus est concatenatus. Ephemer. Acad. Nat. Cur., 1695–96, 2. dec. ann. 3, p. 80. Pre-Linn. 1695.1

Hanow, *Michel Christopher* [1695–1773] For some account of his work, and for a portrait, *see* Schumann, E. "Geschichte der naturforschenden Gesellschaft in Danzig, 1743–1892." Festschrift zur Feier des 150-jähricher Bestehens der naturforschenden Gesellschaft in Danzig. 1893. 8°.

Hanow, *M. C.*

—— Erlauterte Merkwürdigkeiten der Natur. 3 vols. Danzig, 1737. 4°. Pre-Linn. 1737.1

i. Anmerkungen über die Blasen der Fische. **1**, 610.
ii. Beschreibung eines Meerochens. **1**, 479 & 648.
iii. Einige berechnete Fischrogen. **1**, 607.
iv. Von einem gestrandeten Schwerdtfische. **1**, 468; **3**, 122.
v. Von einem unerhörten Winterfischzuge, wo zugleich von den Plötzen gehandelt wird. **1**, 596.
vi. Von den Augen der Flunder auf der linken Seite. **3**, 141.
vii. Von einem schwangeren Birgsroger [Perca]. **3**, 142.
viii. Von fremden giftigen Fischstacheln. **3**, 130.
ix. Von jungen Haifischen. **3**, 115.

—— Seltenheiten der Natur und Oeconomie, nebst deren kurzen Beschreibungen und Erörter; aus den Danziger Erfahrungen und Nachrichten ausgezogen und herausgegeben von J. D. Titius. 3 vols. Leipzig, 1753–55. 6 pls. 8°. Pre-Linn. 1753.1

Apparently an edition of the above work.

Hardt, *Herm. van der.* Jonas in carcharia. Helmstadt, 1718. 8°. Pre-Linn. 1718.1

—— Ænigma Tobiæ cum grandi pisce. Helmstadt, 1719. 4°. Pre-Linn. 1719.1

Hartenfels, *George Christopher Petrus ab.* Programma de piscatu. Erfurt, 1691. 4°. Pre-Linn. 1691.1

Hartenstein, *J. F. See* **Hertenstein,** *J. F.*

Hartmann, *Philipp Jacob* [1648–1707] Descriptio anatomica Siluri ventriculi. Misc. Acad. Nat. Cur., 1688 (1689), 2. dec., ann. 7, 80–83. Pre-Linn. 1688.1

Reprinted in Valentini, M. B. "Amphitheatrum Zootomicum," Francofurti, 1720, pt. II, 101–102.

—— [De diverticulo intestinorum in salmone.] Ephemer. Acad. Nat. Cur., 1689, exerc. 1. Pre-Linn. 1689.1

—— (*præses*) Disquisitio de Xiphia sive Gladio. Regiomonti, 1693. 22 p. 4°. Pre-Linn. 1693.1

Joh. Faber, *respond.*

—— Descriptio anatomico-physica Xiphiæ sive Gladii piscis. Ephemer. Acad. Nat. Cur., 1694 (1695), 3. dec., ann. 2, append., 1–22. Pre-Linn. 1695.1

Hartung, *Valent.* De halecum [Harengus] esu et usu. Leipzig, 1615. 4°. Pre-Linn. 1615.1

Hasselquist, *Frederick* [1722–1752] Iter Palæstinum, eller resa til Heliga Landet förrättad infrän år 1749 til 1752, med beskrifningar, rön, anmärkningar, öfver de märkvärdigaste naturalier, pä Hennes Kongl. Maj. 'ts befallning utgifven af Carl Linnæus. Stockholmiæ, 1757. xiv, 619 p. 8°. Pre-Linn. 1757.1

Fishes, p. 324–407.
Post-Linnæan translations are:

Reise nach Palästina in dem Jahren 1749 bis 1762. Herausgegeben von C. Linnæus. Aus dem Schwedischen [übersetzt von T. H. Gadebusch]. Rostock, 1762. xviii, 606 p. 8°.

Voyages and travels in the Levant in . . . 1749–52; containing observations in natural history, physick, agriculture and commerce. . . London, 1766. viii, 456 p. map. 8°.

Voyage dans le Levant, etc. Paris, 1769. 8°.

Hauksbee, *Francis* [1687–1763] An account of some experiments touching the keeping of fishes in water under different circumstances. Phil. Trans. Roy. Soc. London, 1712, **27**, 431–434. Pre-Linn. 1712.1

In boiled water and in water *in vacuo.*

Hawkins, (*Sir*) *Richard* [1562?–1622] For a biographical notice, *see* Barnett, John. "Sir Richard Hawkins, the complete seaman." Cornhill Mag., 1910, **28**, 535.

—— The observations of Sir Richard Hawkins, Knight, in his voiage to the South Sea, Anno Domini, 1593. London, 1622. Pre-Linn. 1622.1

Habits of dolphin, 66–67; bonito, 68; shark, voracity and receiving young in mouth, 68–70; flying fish, 70; swordfish and thresher fighting whale, 71–72.

A modern reprint in Hakluyt Soc. Works, London, 1847, no. 1. Another reprint, along with voyages of William and Sir John Hawkins, in Works, 1878, no. 57.

Haydenpuecher, *Jo. Ge.* (*respond.*) Disputatio de iure venandi, aucupandi et piscandi. (In Mor de Nigromonte, G. Pre-Linn. 1602.1, p. 128–144) Pre-Linn. 1602.1

D. Hier. Rath, *præses.*

Hebenstreit, *Johann Ernst* [1703–1757] De collectione piscium Africanorum, pro ed. ac herbaria viva convinari solent modo parata. Comm. Litt. Norimbergæ, 1733, 35. Pre-Linn. 1733.1

—— De organis piscium externis. Inaug. Dissert. Lipsiæ, 1733. 20 p. figs. 4°. Pre-Linn. 1733.2

Reviewed in Comm. Litt. Norimbergæ, 1733, 409, and *Ibid.*, 1734, 61.
Copy, A. M. N. H.

Heger, *Johan Ludwig.* Landwirthschaftliche Teich- und Weyher-Lust, oder gründliche Information zur edlen Fischerei, *etc.* Frankfurt & Leipzig, 1727. xx, 135 p. 8°. Pre-Linn. 1727.1

Heins, *Martin* (*præses*) Analysis exercitationes 225. J. C. Scaligeri ad Cardanum de piscium habitaculis et allēlophagia, seu mutuâ Laniens. Inaug. Dissert. Wittebergæ, 1639. 4°. Pre-Linn. 1639.1

Thomas Saurmann, *respond.*

Hellant, *Andreas* [–1789] (*respond.*) Dissertatio de novo in fluviis Norlandiarum piscandi modo. Om et nyt sät at fiska i Norländska elfwar. Inaug. Dissert. Upsaliæ, 1738. 28 p. pl. 4°. Pre-Linn. 1738.1

A. Celsius, *præses.* Copy, N. Y. P.

—— Berättelse om laxens alstrande, i ackt tagit vid des fiskande. K. Svensk. Vetensk. Acad. Handl., 1745, 267. Pre-Linn. 1745.1

—— Bericht von Erzeugung des Lachses, wie solche bey seine Fischerey ist beobachtet worden. König. Schwed. Akad. Abhandl., 1745, **7**, 271–283. Pre-Linn. 1745.2

See note under Kästner, A. G. *See* also Hellant, A., Add. 1762.1.

Heller, *Johann.* Neues Jag und Weydwerck-Buch, das ist, ein gründliche Beschreibung vom Anfang der Jagten. Neu vom adelichen Weydwerk der Falcknerey, Beyssen und Federspiel; dergleichen vom Fischfangen. Frankfurt-am-Mayn, 1582. fol. Pre-Linn. 1582.1

Helmont, *Jean Baptiste van* [1577–1644] Opera omnia, etc. Francofurti, 1707. 8°. Pre-Linn. 1707.1

Numerous incidental references to fishes in medicine. Book well indexed.
An earlier ed.: Frankfort, 1682.

Helsing, *Joh.* (*præses*) Dissertatio de carne piscium. Hafniæ, 1714. 8 p. 4°. Pre-Linn. 1714.1

Chr. Lehman, *respond.*

Helvig, *or* **Helwing,** *Christopher* (*præses*) [1679–1714] Dissertatio specimen pharmacologiæ sacræ de antimonio, cicuta et pisce Tobiæ sive siluro. Gryphiswaldiæ, 1708. 34 p. 4°. Pre-Linn. 1708.1

E. G. von Seelen, *respond.*

Helwing, *Georg Andreas* [1666–1748] Lithographia Angerburgica sive lapidum & fossilium in districtu Angerburgensi & ejus vicinia ad trium vel quatuor milliarii spatium in montibus, agris, arenofodinis & imprimis circa lacuum littora & fluviorum ripas collectorum brevis & succincta consideratio. 2 vols. [in 1] Regiomonti, 1717–20. 96, 132 p. 6 pls. 4°. Pre-Linn. 1717.1

Glossopetras, p. 59–60.

—— Eigentliche Nachricht von der sogenannten Blau-Asche [Thymallus] im Preussen. Samml. Natur u. Med., Kunst u. Litt.-Gesch., Breslau, 1718, 1391. Pre-Linn. 1718.1

Henchelin, *Caspar* (*respond.*) Disputatio de domino proprietatis et ejus acquirendi modus . . . et quidem de venatione, piscatione et inventione. Inaug. Dissert. Tubingiæ, 1599. 4°. Pre-Linn. 1599.1

Henricus Bocer, *præses.*

Henelius, *Nicol.* Silesiographia renovata. 2 vols. Wratislaviæ [Breslau], 1704. 4°. Pre-Linn. 1704.1

Fishes of Silesia described.

Hennike, *J. C.* Nachricht von einer besondern Fischkrankheit. Frankisch. Samml., Nürnberg, 1756, **2**. 23 p. Pre-Linn. 1756.1

Heppe, *C. Wilh. von.* Der in denen, bey dem Forstjagdwesen und der Fischerey vorkommenden Fällen sich selbst räthende Jäger. Augspurg, 1753. 8°. Pre-Linn. 1753.1

Another ed.: Augspurg, 1763.

—— Der sich selbst räthende Jäger, oder 117 auserlesene, zum Theil sehr delicate Casus und streitige Fälle, welche bei dem Forst-, Jagd- und Fischerei-Wesen vorkommen. Augsburg, 1754. 8°. Pre-Linn. 1754.1

Heresbach, *Conrad* [1509–1576] Rei rusticæ libri quatuor . . . Thereutices, hoc est, de venatione, aucupio atque piscatione compendium. Coloniæ, 1570. 4°. Pre-Linn. 1570.1

Conrad Heresbach is one of the old farmers discussed by Donald G. Mitchell, in his "Wet days at Edgewood." (1865.1) His book as a whole, and particularly those parts relating to fish and fishing, were often reprinted. The most notable editions will be given by titles and others by years. Bosgoed lists an ed., Coloniæ, 1571 in 8°. The next ed. seems to be:

—— Rei rusticæ libri IV universam rusticam disciplinam complectens. Item de venatione, aucupio atque piscatione compendium. Coloniæ. 1573. vii, 713, 12 p. Pre-Linn. 1573.1

Fishes, pp. 690–713.
Other Latin eds.: Cologne, 1594, 1595, 1603.
The first English version is:

Heresbach, *C.*

—— Foure bookes of husbandry, collected by M. Conradus Heresbachius, Counseller to the hygh and mighty Prince, the Duke of Cleve; conteyning the whole arte and trade of husbandry, with the antiquitie and commendation thereof. Newely Englished, and increased by Barnabe Googe, Esquire. London, 1577. iv, 193 p. 4°. Pre-Linn. 1577.1

Other English eds., or more probably reprints, are: London, 1578, 1586, 1594, 1596, 1600, 1601, 1604. Next comes Googe's enlarged ed. of 1614, "The whole art and trade of husbandry," etc. followed by Gervase Markham's greatly augmented version of 1631. Copies, 1570 (Latin), & 1614 (English) eds., N. Y. P.

—— The whole art of husbandry contained in foure bookes, etc. Booke iv. Of poultrie, fowle, fish . . . and the art of angling . . . now renewed, corrected, enlarged and adorned with all the experiments and practises of our English nation, which were wanting in the former editions. By Captaine Garvase Markham. London, 1631. 4°. Pre-Linn. 1631.1

—— Libri quarti de re rustica pars quæ agit de piscinis et piscium vivariis. Ejusdem thereutices pars tertia de piscatione. Helmstadt, 1657. 4°. Pre-Linn. 1657.1

The editor, Hermann Conringius, has here brought together the matter relating to fishing and fishponds contained in "De re rustica" and the "Thereutices." For a modern English version of "De piscatione," which aims at "rendering as nearly as possible the style and colour of the epoch," with a brief introduction by T. Westwood, *see* "The angler's notebook and naturalists' record," etc., pp. 117, 133, 149, 165. London, 1880.
The most famous English ed. is:

—— The perfect husbandman, or the art of husbandry. In four books . . . Book IV. Of poultry, fowle, fish and bees with the . . . art of angling. By C. H., B. C., and C. M., ingenious artists. London, 1658. vi, 385 p. 4°. Pre-Linn. 1658.1

Hérissant, *François David* [1714–1773] Recherches sur les usages du grand nombre de dents du *Canis carcharias*. Mém. Acad. Sci. Paris, 1749 (1753), 155–162. 3 pls. — Comment. Lips., 1754, **3**, 477. Pre-Linn. 1753.1

Herlein, *J. D.* Beschryvinge van de volk-plantinge Suriname; vertonende de opkomst dier zelver colonie, etc. Mitsgaders een vertoog . . . van de water- en pluimgediertens. Leeuwarden, 1718. pls. 4°. Pre-Linn. 1718.1

Visschen en zeegedrochten, p. 193–201.

Hernandez, *Francisco* [1514–1578] For a notice of this author (who was physician to Philip II) and of his writings, *see* Rich, O. "A catalogue of books relating principally to America 1493–1700." London, 1832. pp. 72–74. Also Sabin, J. "Bibliotheca Americana," vol. VIII, pp. 239–241 (1868.1), and Lichtenstein, M. C. H., in Abhand. Akad. Wiss. Berlin, 1827, 88–127.

—— Quatro libros de la naturaleza y virtutes de las plantas y animales, que estan recevidos en el uso de medicina en la Nueva España y el metodo y correccion y preparacion, que para administrallas se requiere, con lo que Francisco Hernandez escrivio en lengua latina. . . . Traducido y aumentados muchos simples y compuestos y ochos muchos secretos curativos por Fr. Francisco Ximenez. Mexico, 1615. 4°. 203 p. Pre-Linn. 1615.1

A modern reprint of this is:

Cuatro libros de la naturaleza y virtudes medicinales de las plantas y animales de la Nuevo España. Extracto de las obras del Dr. F. Hernandez. Anotados, traducidos y publicados en Mexico el año de 1615 por Fr. Francisco Ximines . . . Ahora por primera vez reimpreso . . . bajo la direccion del Dr. N. Léon. Morelia, 1888. lii, 300 p. pl. 8°.

—— Rerum medicarum Novæ Hispaniæ seu thesaurus, plantarum, animalium, mineralium Mexicanorum historia ex Francisci Hernandi Novi Orbis medici primarii relationibus in ipsa Mexicana urbe conscriptis à Nardo Antonio Reccho . . . Collecta notis illustrata; cum indice, et historiæ animalium et mineralium libro. Romæ, 1628. 950 p. Pre-Linn. 1628.1

This is the first ed. of Recchus' Latin version. Others are: Rome, 1641, 1648–49, 1651. There is said to be an earlier Latin translation, Rome, 1626, editor not known. The most valued edition of all is:

—— Nova plantarum animalium et mineralium Mexicanorum historia a Francisco Hernandez medico. In Indiis præstantissimo primum compilata, deinde a Nardo Antonio Reccho in volumen digesta, a Io. Terentio, Io. Fabro, et Fabio Columna Lynceis notis, & additionibus longe doctissimis illustrata. Cui demum accessere aliquot ex principis Federici Cæsii frontispiciis theatri naturalis phylosophicæ tabulæ una cum quam plurimis iconibus, ad octingentas, quibus singula contemplanda graphice exhibentur. Romæ, 1651. Pre-Linn. 1651.1

Fishes, folios 76–88.
Hernandez prepared 16 folio volumes on

the plants, animals and minerals of Mexico. An edition of the "Opera" (most parts hitherto unpublished) was begun at Madrid, 1790, but got no further than the issuing of "De historia plantarum," etc.

Herodotus [*c.* 484–425 B. C.] For a sketch of his life and a commentary on his works, together with bibliographical details about their publication, *see* article in Encyclopædia Britannica, vol. XIII, 11. ed., 1910, by George Rawlinson & E. M. Walker.

—— Historiæ. Venice, 1474. fol. Pre-Linn. 1474.1

Other early eds. are: Rome, 1475; & Venice, 1494 & 1502. Copies of these in H., Y., Col., & L. C.

An English translation of books i & ii of the "Historiæ" was published in London, 1584, but the first complete English version is:

—— The Aegyptian and Grecian history of Herodotus, translated from the Greek by Isaac Littlebury. 2 vols. London, 1709. Pre-Linn. 1709.1

2nd & 3rd English eds. are: London, 1723 & 1737.

Editions in various languages have appeared, too numerous to mention. The history of Herodotus is most available for present day English readers in the 4 vol. edition by George Rawlinson, New York, 1866. The references below apply, however, to any edition.

Ichthyophagi: Babylonian, book i, chap. 200; of the Nile, book ii, chap. 77; of Elephanta, book iii, chap. 77. Fishes of the Nile, book ii, chap. 77. Habits of Nile fishes, *Ibid.*, chap. 93. Fishes in Lake Moeris, *Ibid.*, chap. 149. Fishes of Lake Prasias in Pæonin fed to horses, book v, chap. 17. Herodotus is said to refer to fossil fishes of Mt. Lebanon, but this has not been confirmed.

Herrera y Tordesillas, *Antonio* [1549–1625] Historia general de los hechos de los Castellanos en las islas y tierra firme del Mar Oceano. 4 vols. Madrid, 1601–15. fol. Pre-Linn. 1601.1

Contains accounts of the fishes of the West Indies and of fishing with the remora.

Various translations & editions follow.

—— Description des Indes Occidentales, qu'on appelle aujourdhuy le Noveau Monde, etc. Amsterdam, 1622. fol. Pre-Linn. 1622.1

—— Nieuwe Werelt, anders ghenaempt West-Indien. Amsterdam 1622. fol. Pre-Linn. 1622.2

—— Novus orbis, sive descriptio Indiæ occidentalis, metaphraste G. Barlæo, etc. Amstelodami, 1622. fol. Pre-Linn. 1622.3

—— Beschreibung dero Insulen und dess festen Lendes Jenseit dess hohen grossen Meers, so man nennt West Indien (In De Bry. America. Pt. xii. — German. Zwölffter Theil der newen Welt. 1623. fol.) Pre-Linn. 1623.1

—— The general history of the vast continent and islands of America, commonly called the West Indies, from the first discovery thereof: with the best account the people could give of their antiquities. Translated by Capt. John Stevens. 6 vols. London, 1725–26. maps. cuts. 8°. Pre-Linn. 1725.1

Other eds. are: Amsterdam, 1622 (Latin); Paris, 1660 & 1671; Antwerp, 1728; Amberes, 1728; Madrid, 1726 & 1729–30; London, 1745. Found also in Churchill's "Collection of Voyages," vol. V, 1732; and in Kerr's "Voyages and Travels," vols. III & V, 1824.

Herrera's account of Orellano's descent of the river Amazon, 1540–41, from the 6th decade of his "Historia general," has been translated and edited by Markham in Hakluyt Soc., Works no. 24, 1859. Fishes, sec. xxv of this.

Hertenstein, *Johannes Fridericus* (*præses*) Dissertatio de magno pisce, qui Jonam vatem deglutivit. Wittembergæ, 1705. 2 pl. 4°. Abstract in Nouv. Liter. German. Hamburg, 1705, 447. Pre-Linn. 1705.1

"Carchariam fuisse asserit." Kirchmaier, *respond.*

Hextor, *J. van,* & **Nylant,** *P.* *See* **Nylant & Hextor.**

Heyke, *Detlof.* Fische die in Austerschalen gefunden worden (Ophidium). König. Schwed. Akad. Abhandl., 1744, **6**, 116–117. Pre-Linn. 1744.1

See note under Kästner, A. G., Pre-Linn.

—— Om fiskar [Ophidium] funna i Ostronskal. K. Svensk. Vetensk. Acad. Handl., 1744, **6**, 116–117. Pre-Linn. 1744.2

[**Higginson,** *Francis*] [1587–1630] New England's plantation; or, a short and true description of the commodities and discommodities of that countrey. Written by a reverend divine now there resident. London, 1630. 11 leaves. 4°. Pre-Linn. 1630.1

The 8th leaf has the following caption: "Of the waters of New England with the things belonging to the same." This gives an account of the fish and their abundance.

Reprinted in Force's Historical Tracts, 1, tract 12. Also in Coll. Mass. Hist. Soc. 1792 (1806), 1. Extracts in Rept. U. S. Fish. Comm. 1871–72 (1873), 159–160.

Hildebrand, *Wolfgang.* Neue augirte . . . viel vermehrte Magia Naturalis. Dass ist Kunst und Wunderbuch, darinnen begriffen . . . wie man nemlich mit . . . Fischen . . . ver-

Hildebrand, *W.*
richten . . . und zu Nutz gebrauchen und damit die Zeit vertreiben kan, etc. Erfurt, 1664. 4°. Pre-Linn. 1664.1

Hildegarde de Pinguia (*also styled* **Saint Hildegard**. *Abbess of Bingen*) [*c.* 1098–1179] For accounts of the life and natural history observations of this remarkable personage, *see* Jessen, Carl. "Ausgabe der Hss. der medic.-naturhistor. Werke der heiligen Hildegard." Sitzber. Akad. Wiss. Wien, mat.-naturw. Kl., 1862, **45**, 1. Abth., 97–116; and Mozans, H. J. "Women in Science." New York, 1913, 232–235. Also Geisenheyner, L. 1911.1; Kaiser, P. 1901.1; Reuss, F. A. 1835.1; Wasmann, E. 1913.1 & 1913.2; Fischer-Benzon, R. van. Add. 1895.1.

—— Physica S. Hildegardis elementorum, fluminum aliquot Germaniæ, metallorum, leguminum, fructuum et herbarum, arborum et arbustorum, piscium, denique, volatilium et animantium terræ naturas et operationes, libris IV, mirabili experientiâ posteritati tradens. Argentorati [Strasburg], 1533. fol. Pre-Linn. 1533.1

This is the *editio princeps.*
Another ed. of the same year bears the title:

—— Physica elementorum sanctæ Hildegardis, sive subtilitatum diversarum naturarum creaturarum libri IX. Argentorati, 1533. fol. Pre-Linn. 1533.2

—— Hortus sanitatis, quatuor libris quæ subsequuntur complectens; de animalibus & reptilibus; de avibus & volatilibus; de piscibus & natatilibus; de gemmis & in venis terræ nascentibus. Argentorati, 1536, fol. Pre-Linn. 1536.1

"Conspectum hujus editionis vide apud Urb. Frid. Bened. Bruckmannum in libello cui titulus est Untersuchung ob dem Frauenzimmer erlaubt sei, die arzeneykunst aus zu üben." Title and comment from Gronovius.

—— Titulo physicæ cum Georg. Kraut experimentario medicinæ. Argentorati, 1544. fol. Pre-Linn. 1544.1

This is a revision by Kraut of the earlier book. Kraut also published at Argentorati in 1544 under his own name another book based on the work of Hildegarde.
For a present day edition of this work of Hildegarde, *see:*

Reuss, F. A. "Der heiligen Hildegard subtilitatum divers. naturarum creaturarum libri IX." 1859.

Another modern reprint is in Migne, J. P. "Patrologia latina." Paris, 1855, vol. CXCVII. It is also found in editions of her collected works by Migne and by Pitra, both Paris, 1882.

"Wir besitzen aus der ganzen Zeit vor Albertus kein Werk von solcher Bedeutung für Deutschlands älteste Naturgeschichte wie die Physica Hildegardis vom Bingen." Jessen.

Hill, (*Sir*) *John* [1716–1775] A general natural history; or new and accurate descriptions of the animals, vegetables and minerals of the different parts of the world, etc. 3 vols. London, 1748–52. 56 pls. Pre-Linn. 1748.1

Published also as 3 separate volumes. Vol. I, bears the following sub-title:

—— The history of fossils. 1748. 11 pls. Pre-Linn. 1748.2

Pl. viii. Fossil teeth, palates, vertebræ and whole fishes.
Vol. III is entitled:

—— An history of animals; containing descriptions of the birds, beasts, fishes and insects of the several parts of the world. . . . In these the characters, qualities, and forms of the several creatures are described, the names by which they are commonly known, as well as those by which authors who have written on the subject have called them are explained. London, 1752. iv, 584 p. 27 col. pls. Pre-Linn. 1752.1

Class v. Fishes. p. 201–318.
Another ed. of the 3rd volume, London, 1773.
For a later ed. of the "General Natural History," *see* Hill, John. 1771.1.

Hippocrates [B. C. 460–375 *or* 377] For a biography, *see* Fabricius, Johann Albrecht. "Bibliotheca Græca," 1705–1728, vol. XII, p. 675. Also Encyclopædia Britannica, 1910, XIII, 517–518. For discussions of the zoological features of the work of Hippocrates, *see* Burckhardt, R., 1904.1, & Eastman, C. R., 1906.2. For an account of the various editions of his "Opera," *see* Fischer, Joh. Henr. "De Hippocrate, eius scriptis eorumque editionibus." Coburgi, 1777.

—— Opera omnia. Venetiæ, 1526. fol. Pre-Linn. 1526.1

Editio princeps in Greek. No separate Pre-Linnæan ed. of the "Regimen" has been found. Other early Greek eds. of the "Opera" are: Basel, 1538, & Venice, 1588 (Greek and Latin) fol. Other early eds. (presumably in Latin): Frankfort, 1595, 1621, 1624; Leyden, 1643 & 1665.
For modern versions of the "Regimen," *see:*

Koraes, N. "[On regimen] Notes sur le traité du régime dans les maladies aiguës et de l'ancienne médicine d'Hippocrate." Athens, 1887.

Kühn, (editor), "On regimen, books I–IV. (In Corpus hippocraticum. 1826–27)"

The 87 treatises forming the so-called Hippocratic collection on regimen have also been edited by Ermerius, 1859–65, and by Littré, 1839–61 (with translation). The treatise "On regimen" is doubtfully by the great physician of Kos, nevertheless it embodies what has been called the Koan system of zoological classification. In book ii, fifty-two species of animals are enumerated, seventeen of which are fishes.

Högström, *Pehr* [1714–1784] Beschreibung des schwedischen Laplands. (In Ehrenmalm, Arvid. Reise durch Westnordland nach der Lapmark. Kopenhagen, 1748. pls. 8°.) Pre-Linn. 1748.1

Also in Arkstee & Merkus. "Allgemeine Historie der Reisen, etc." 1771, vol. XX.
Contains some notes on fishes.

Hövel, *Heinr. von.* Neuwer wunderbarlicher Thiergarten: in welchem der Unvernünfftigen Irdischen Gethieren, auch der Vögeln und Fischen Natur und Eygenschafften beschrieben etc. 3 parts. Franckfurt-a.-M., 1601, 469 p. 19 Holzschn. 4°. Pre-Linn. 1601.1

Second ed.: Franckfurt, 1613. 4°.

Hoffmann, *Moritz* [c.1622–1698] Mustela piscis (Aalruppen, Quappen) [*Lota vulgaris*] anatomice examinata. Ephemer. Acad. Nat. Cur., 1722, cent. 9 & 10, 449–450. figs. — Act. Erudit., 1723, 143. Pre-Linn. 1722.1

Hohberg, *Wolff Helmhard von.* Georgica curiosa aucta, das ist: unständlicher Bericht und klarer Unterricht von dem adelichen Land- und Feld-Leben auf alle in Deutschland üblichen Land- und Haus-Wirtschaften 3 vols. Nürnberg, 1701. fol. Pre-Linn. 1701.1

Reprinted in 1716.
"A very curious work with 317 fine engravings in the text. It is a complete encyclopædia of 17th century rural life in Germany." — W. & S.
According to J. Wimmer, in his "Geschichte des deutschen Bodens," this work treats extensively of fishes of the Danube and northeast Germany in the 17th century.
Bosgoed lists it under Hochberg, — Freiherr von.

Holst, *Georg.* En liden artig og konstig fiskebog om adskillige fiskefang, etc. Hafniæ, 1649. 4°. Pre-Linn. 1649.1

Translated from the German.

Homer [*c.* 11th *or* 10th Cent. B. C.] For critical comments on Homer and his poems, together with a list of the best modern eds., *see* article by D. B. Monroe in Encyclopædia Britannica (11th ed.), 1910, vol. XIII. For notes on the animals of the Iliad and Odyssey, *see* Groshans, G. P. 1846.1; Kums, A. 1897.1; MacDonald, W. B. 1846.1; & Moulé, L. 1909.1.

—— Opera (Iliad & Odyssey). Florence, 1488. Pre-Linn. 1488.1

The *editio princeps*. Other early and valuable eds.: Venice, 1504 & 1517. No others will be listed. A bibliography of Homer would fill several volumes.
The references to fish (eel & shark) and fishing in Homer are the earliest known in literature: — Iliad, xvi, 406 & 745; xxi, 352 (eels & other fish in river Xanthus), & 692; xxiv, 80: Odyssey, v, 432; xii, 251 & 331; xix, 113; xxii, 383; xxiv, 418.

Hooge, *Romein de* [*fl.*1662–1688] Les Indes Orientales & Occidentales, & autres lieux; représentés en très belles figures, qui montrent au naturel . . . poissons, etc. Leiden, [c. 1680]. 48 pls. obl. 4°. Pre-Linn. 1680.1

Descriptions in French and Dutch. Hooge was a Dutch engraver. His work is preserved in the British Museum.

Hooke, *Robert* [1635–1703] Micrographia or some physiological descriptions of minute bodies made by magnifying glasses, with observations and inquiries there upon. London, 1665, 34, 246 p. 38 pls. sm. fol. Pre-Linn. 1665.1

Scales of fishes, p. 162.

Horrebow, *Niels* [1712–1760] Tilforladelige Efterretninger om Island. Kiobenhavn, 1752. 8°. Pre-Linn. 1752.1

The 1st ed. Various versions follow.

—— Description physique, historique . . . d'Island. Copenhagen, 1752. Pre-Linn. 1752.2

Another French edition, 2 vols.: Paris, 1764. 12°.

—— Zwerlässige Nachrichten von Island, aus dem Dänischen übersetzt. Copenhagen & Leipzig, 1753. map. 8°. Pre-Linn. 1753.1

—— De tegenwoordige staat of omstandige beschrijiving van het groot eyland IJsland. Bevattende . . . een omstandig bericht van de visschen, de vischvangst, toebereiden en drogen der visschen. Amsterdam, 1754. 4°. Pre-Linn. 1754.1

Herring and cod; catching, preparation of, etc., pp. 48–64.

—— The natural history of Iceland: containing a particular and accurate account of the . . . fishes, &c. London, 1758. xx, 207 p. map. fol. Pre-Linn. 1758.1

Fishes, p. 70–84; 89–90.
This is Horrebow's own work, but it abounds in foot-note references to Anderson, J., this section (*q. v.*).

Hortop, *Job* [*fl.* 1567–1591] The rare travailles of Job Hortop. Wherein is declared the dangers he escaped in his voyage to Gynnie . . . Wherein also he discovereth many strange and wonderfull things . . . also of monstrous beasts, fishes and foules. London, 1591. 4°. Pre-Linn. 1591.1

Hortus Sanitatis. *See* **Cube,** *J. von.*

Howlett, *Robert.* Angler's sure guide; or, angling improved and methodically digested. By R. H., forty years a practitioner in this art. London, 1700. 8°. Pre-Linn. 1700.1

Contains information about material for fishing, nature and habits of fish, preserving fish; fish ponds and laws of angling.

Other eds.: London, 1706, 1710, 1720, 1732, 1736.

Copies 1706 & 1732 eds., N. Y. P.

Hughes (*Rev.*) *Griffith.* The natural history of Barbados, in ten books. London, 1750. vii, 14, 314, 20 p. 29 pls. fol. Pre-Linn. 1750.1

Fishes, p. 299–314.

Humble, *Nils* (*respond.*) Disputatio de piscaturâ harengorum in Roslagiâ. Inaug. Dissert. Upsaliæ, 1745. 4°. Pre-Linn. 1745.1

Elias Frondius, *præses.*

Hume, *Francis.* Experiments on fish and flesh preserved in lime-water. Phil. Trans. Roy. Soc., 1753 (1754), **48**, 163–164. Pre-Linn. 1754.1

German translations in: Physical. Patriot., Hamburg, 1756, **1.** — Allg. Magaz. Natur. Kunst. Wissen., **6.** — Wittenb. Wochenbl., 1770, **3,** 101. — Beyträg. Naturg. Mineralreiches, Th. 1.

I

Ilstrom, *Johann.* Vom Fischfange in Preussen, und dem Fischfange mit Kockelskernern. Samml. Nat. u. Med., Kunst u. Litt.-Gesch., Breslau, 1721, 15. Vers., 181. Pre-Linn., 1721.1

—— Beskrifning om körfogelens [*Mergus merganser*] nytta, när fiskehus blifva bygde för honom uti salt-eller insiö-vikar. K. Svensk. Vetensk. Acad. Handl., 1749, **10**, 190–196. Pre-Linn. 1749.1

—— Beschreibung des Gebrauches der Tauscher-Gans, wenn für sie Fisch-Haüser an Meerbusen oder Seen im Lande erbauet werden. König. Schwed. Akad. Abhandl., 1749 (1754), **11**, 197–208. — Analect. Transalp., 1762, **2**, 194–197. Pre-Linn. 1754.1

See note under Kästner, A. G., Pre-Linn.

—— Mittel, um eine Menge Fische mit der Angel oder Netze zu fangen. Brem. Magaz., 1757, **1**, 2. St., no. 59. Pre-Linn. 1757.1

Imperato, *Ferrante* [1550–1625] Historia naturale, nella quale si tratta della diversa condizion de minere, pietre preziose, e altre curiosita, con varie istorie di piante e animale. Neapoli, 1593. fol. Pre-Linn. 1593.1

This is the exceedingly rare and almost unknown first edition. The following, a "second impression" it is called, is commonly taken for the first edition.

—— Dell' historia naturale . . . libri XXVIII, nella quale ordinatamente si tratta della diversa condition di minere e pietre. Con alcune historie di piante & animali; sin' hora non date in luce. Napoli, 1599. xxiv, 791 p. figs. Pre-Linn. 1599.1

—— Discorsi intorno a diversi cose naturali. Napoli, 1628. 2 pls. 4°. Pre-Linn. 1628.1

Contains a reference to object called "batrachite," or "boufonite."

—— Historiæ naturalis libri XXIIX. Accesserunt nonnullæ Johannis Mariæ Ferri adnotationes ad librum XXVIII. Nunc primum ex italica in linguam conversa latinam. Coloniæ, 1695. 928 p. figs. 4°. Pre-Linn. 1695.1

Probably the best ed. of the "Historia."

Other eds. in Italian are: Naples, 1610, 4°, & Venice, 1672, fol. with 669 woodcuts. Versions are said to have been issued in Latin, at Cologne, Leipsic & Bremen in 1692 or 1695.

Copies of early eds. in H., Arn., A. M. N. H., P. A. S.

Imperato, who was a pharmacist of Naples, possessed a cabinet of curiosities which are described in the work listed above. According to Schröter and Haller, the real writer of the book was Nicolas Antonio Stelliola, who did the work for a price, while Imperato wrote himself down as the author. The descriptions of animals form a comparatively small part of the whole, which has mainly to do with agriculture and mineralogy. Among the illustrations is the earliest printed figure of the remora.

Ingrams, —— Tractatio de torpedine anglice. (In Student of Oxford, no. 2.) — Hannover. Gel. Anz., 1750, 83. Pre-Linn. 1750.1

Isachius, *Alfonsus.* De venatione tractatus, in quo de piscatione, aucupio, sylvestriumque insectatione agitur. Regii, 1570. 8°. Pre-Linn. 1570.1

2nd ed.; Regii, 1625. 4°.

Isidore of Seville (Lat. **Isidorus Hispalensis**) [*c.* 560–636] Liber etymologiarum. Augsburg. 1472. Pre-Linn. 1472.1

Probably the 1st ed.; another, Venice, 1483. Copies, A. T. M., U. C.

—— Originum libri xx, variis lectionibus et scholiis illustrati opera Bonav. Vulcanii. Basiliæ, 1577. fol. Pre-Linn. 1577.1

Lib. XII., de animalibus.

—— Originum, seu etymologiarum, libri xx. Parisiis, 1580. Pre-Linn. 1580.1

Lib. VI, cap. 6. De ordine creaturum. Thirty or more species of fish are enumerated, and indications are given in what seas and rivers they occur.

—— Opera. Parisiis, 1601. 1 vol. fol. Pre-Linn. 1601.1

Modern eds. of the "Etymologiarum" are:

Isidori Hispalensis episcopi etymologiarum libri xx. edidit F. V. Otto. (In Lindemann. Corpus grammaticorum Latinorum veterum, &c. vol. III. Lipsiæ, 1833. 4°.)

Isidori Hispaliensis episcopi Etymologiarum sive originum libri xx recognovit, etc. W. M. Lindsay edidit. 2 vols. Oxonii, 1911.

J

J., *A.* A conjecture concerning the bladders of air that are found in fishes; illustrated by an experiment suggested by Robert Boyle. Phil. Trans. Roy. Soc., 1675, **10**, 310–311. Pre-Linn. 1675.1

Often erroneously ascribed to Boyle.

Jacob, *Giles,* [1686–1744] The country-gentleman's vade mecum; containing . . . fish and fishing, fish-ponds, etc. London, 1717. 8°. Pre-Linn. 1717.1

Fishes, p. 25–31.

—— The compleat sportsman; in three parts. Part iii: Of fish and fishing, etc. London, 1718. xii, 142, iv p. 12°. Pre-Linn. 1718.1

Fish and fishing, p. 114–152.

—— Game law; and of hawking, hunting, fishing and fowling. 7. ed. London, 1740. 8°. Pre-Linn. 1740.1

Jacobæus, *Oliger* [1650–1701] Aci marini anatomi. Acta Med. Phil. Hafn., 1673 (1675), **2**, 140–154. Pre-Linn. 1675.1

Not seen. Carus & Engelmann assign this title to Borrich, O. (Pre-Linn. 1675.1); Agassiz to Jacobæus; and both Gronovius & Walbaum list it under both authors.

—— Anatome piscis centrinæ, Italis pesci porco. Act. Soc. Sci. Reg. Hafn. 1677–79 (1680), **5**, 251–253. Pre-Linn. 1680.1

—— Anatome piscis torpedinis motusque tremuli examen. Acta Soc. Sci. Reg. Hafn., 1677–79 (1680), **5**, 253–259. Pre-Linn. 1680.2

—— De Lampetra eiusque pulmonibus et anguilla. Act. Med. Phil. Hafn., 1677–79 (1680), **5**, 259–261. Pre-Linn. 1680.3

—— Museum regium seu catalogus rerum tam naturalium, quam artificialium quæ in basilica bibliothecæ augustissimi Daniæ Norvegiæq; Monarchæ Christiani V, Hafniæ asservantur, &c. Hafniæ, 1696. 214 p. 37 pls. fol. Pre-Linn. 1696.1

Some marine fishes and their parts are described.

—— Auctarium rariorum musei regii. Hafniæ, 1699. fol. Pre-Linn. 1699.1

—— Museum regium, seu catalogus rerum tam naturalium, quam artificialium, quæ in Hafniæ asservantur in basilica bibliotheca Friderici IV. Daniæ & Norwegiæ monarcha . . . ab O. Jacobæo . . . quondam describtus, nunc vero magna ex parte auctior uberioribusque commentariis . . . illustratus, accurante J. Lauerentzen. Havniæ, 1710. 260 p. 56 pls. Pre-Linn. 1710.1

This is a revised and enlarged edition of the 1696 work. *See* also Laurenzen, J., this section.

Jago, *Georges* (*Curé de Cornuailles*) [Descriptions of and notes on a few kinds of fishes, communicated to John Ray, and published by the latter in his Synopsis methodica piscium, 1713. (*q. v.*)] Pre-Linn. 1713.1

Reference from Cuvier & Valenciennes.

Jeraucurius, *Anan.* Explicatio characterum, qui inventi fuerunt in lateribus duarum Halecum [Herring], quæ fuerunt in Dania et Norwegia captæ. 1588. fig. 8°. Pre-Linn. 1588.1

Johnson, *Th[omas]* [*c.* 1561–1644] Cornucopiæ, or, Divers secrets, wherein is contained the rare secrets of man, beasts, foules, fishes and such like . . . not before committed to be printed in English: newlie drawen out of divers Latine authors into English. 1595. 4°. Pre-Linn. 1595.1

Jonston, *John* [1603–1675] Thaumatographia naturalis, in decem classes divisa, in quibus admiranda cœli, elementorum, meteororum, fossilium, plantarum, avium, quadrupedum, exsanguium, piscium et hominis. Amstelodamæ, 1632. 501 p. fol. Pre-Linn. 1632.1

Other eds. appeared in 1632, 1633, 1661 & 1665, and an English version (noted below) in 1657.

—— Historia naturalis de piscibus et cetis libri v, cum æneis figuris. [Pars I]. Francofurti ad Mœnum, [1649]. 228 p. 47 pls. fol. Pre-Linn. 1649.1

This work is in two parts; the title-page of the first part is undated, and that of the second part, dated 1650, reads:

Historiæ naturalis de exsanguibus aquaticis libri IV, cum figuris æneis Francofurti-ad-Mœnum, 1650.

The two parts of this work were republished under a new title at Amsterdam in 1657. There are also other eds. of 1665, 1677, & 1718. This last appears under a new title quoted later.

According to Agassiz, Jonston's previously published works on quadrupeds, birds, fishes, and insects, were united and published in folio under the following title and in various editions as indicated in footnote.

—— Historia naturalis animalium. Francofurti, 1650. figs. fol.
Pre-Linn. 1650.1

Other eds. are: Frankfort, 1653 & 1662; Amsterdam, 1657, & 1678 (English).

—— An history of the wonderful things of nature, set forth in ten severall classes. Wherein are contained . . . ix. The wonders of fishes. Written by Johannes Jonstonus, and now rendered into English by a person of quality. London, 1657. Pre-Linn. 1657.

This is a translation of the author's "Thaumatographia naturalis," 1632.

Wonders of fishes, Classis ix, pp. 289–306.

—— Beschryving van de natuur der vissen en bloedloose waterdieren. Amsterdam, 1660. fol. Pre-Linn. 1660.1

—— Theatrum universale omnium animalium, piscium, avium, etc. CCLX tabulis ornatum. Ex scriptoribus tam antiquis quam recentioribus, . . . maxima cura a J. Jonstonio collectum, ac plus quam trecentis piscibus nuperrime ex Indiis Orientalibus allatis, etc. . . . cura Henrici Ruysch. 6 parts [in 2 vols.] Amstelodami, 1718. illust. fol.
Pre-Linn. 1718.1

Tomus I, pars prima. Continet collectionem novam piscium Amboinensium ac historiam naturalem piscium et avium. pp. 1–40. 21 pls.

Tomus I, pars secunda. Historia naturalis piscium. pp. 1–160. 48 pls.

This work is a reprint of the author's "Historia naturalis de piscibus et cetis" (1649), together with other writings by him and by Frederic Henri Ruysch, M. D. This edition of the "Theatrum" is often cited in bibliographies under the name of Ruysch alone, leading to much confusion. *See* Ruysch, F. H. Pre-Linn. 1718.1 Other eds. of the Theatrum are: Heilbronn, 1755–57; Rouen, 1768.

This writer, of a family originally Scotch, was born at Lessno or Lessa, in Posen. His great service was in bringing together into one work the scattered observations of the many writers on ichthyology who had preceded him. Most of his data and figures are copied from Belon, Rondelet, Gesner, Olaus Magnus, Schonevelde, Marcgrave, and others. His books enjoyed great popularity and were many times republished in parts or in whole, in the original Latin or in translation. The various editions are with much difficulty set in order bibliographically. The order above is approximately correct only. An absolutely correct bibliography of Jonston can only be made from the books themselves.

Jorath *or* **Jorach** [12th cent.] De animalibus. MS.

The natural history work by this 12th century oriental, perhaps Syrian writer, no longer extant, is frequently quoted by Albertus Magnus, Vincent de Beauvais, Konrad of Megenberg and Bartholomew Anglicus.

The identity of the author is uncertain. M. Steinschneider (Mém. Acad. Imp. Sci. St. Petersb., 1869, 3. ser. **13**, 128) suggests tentatively that "Jorath Chaldæus," as he is called by Bartholomew, may be the same as "Phoron Chaldeus."

Josselyn, *John* [*fl.* 1633–1675] New Englands rarities discovered: in birds, beasts, fishes, serpents, and plants of that country . . . etc. London, 1672. 114 p. pls. cuts. sm. 8°.
Pre-Linn. 1672.1

Fishes, p. 23–37; 95–97.

This work has been twice reprinted; first in "Archæologia Americana." Trans. & Colls. Amer. Antiq. Soc., 1860, **4**, 133–238. The second is a verbatim et literatim reprint by Wm. Veazie, Boston, 1865. 169 p. 8°. Fishes occupy pp. 59–76. They are discussed in Rept. U. S. Fish Comm. 1871–72 (1873), **1**, 149–150.

—— An account of two voyages to New England . . . etc. By John Josselyn Gent. London, 1674. 279 p. sm. 8°. Pre-Linn. 1674.1

List of fishes, p. 113–114.

The 2nd ed., being a reprint of the 1st dated 1664. The 3rd, identical with both, London, 1675. For a present day reprint, *see* Colls. Mass. Hist. Soc., 1833, 3. ser. **3**, 211–296.

Also reprinted verbatim by William Veazie, Boston, 1865. In this: fishes, p. 7–13; 82–89. Swordfish and whip-tailed shark attack whale, p. 7. Swordfish attacks ship, p. 12. The section on fishes is also found in Rept. U. S. Fish Comm. 1871–72 (1873), **1**, 150–151.

Jovius, *B.* *See* **Giovio,** *B.*

Jovius, *P.* *See* **Giovio,** *P.*

Jussieu, (*Le Cadet*) Observation sur deux petits poissons réunis par le ventre. Mém. Acad. Sci. Paris, 1754, hist., 30. Pre-Linn. 1754.1

Jussieu, *Antoine de* [1686–1758] Recherches physiques sur les pétrifactions qui se trouvent en France de diverses parties de plantes et d'animaux étrangers. Mém. Acad. Sci. Paris, 1721 (1723), (hist., 1–4), 69–75; 322–324. 2 pls. Pre-Linn. 1723.1

Teeth of myliobatid rays figured and described.

—— Sur les pierres appelées yeux de serpents et crapaudines. Mém. Roy. Acad. Sci., 1723 (1725), 205–210. pl.
Pre-Linn. 1725.1

Pharyngeal teeth of Labrus from Brazil.

K

Kaempfer, *Engelbert* [1651–1716] For a sketch of his life, *see* the fourth entry below.

—— Dissertatio medica inauguralis sistens decadem observationem exoticarum. Lugduni Batavorum, 1694. 4°. Pre-Linn. 1694.1

"In ea agitur de . . . torpedine Sinus persici . . ."

—— Amœnitatum exoticarum politico-physico-medicarum fasciculi v, quibus continentur variæ relationes, observationes et descriptiones rerum Persicarum et ulterioris Asiæ, etc. Lemgoviæ, 1712. xiv, 912 p. 16 pls. 4°. Pre-Linn. 1712.1

Torpedo sinus persici, p. 509–515. fig.

—— Anatome torpedinis sinus Persici. (In Valentini, M. B. Amphitheatrum Zootomicum, Francofurti, 1720, pt. II, 115–117. pl. 59.) Pre-Linn. 1720.1

—— The history of Japan, giving an account of . . . its metals, minerals, trees, plants, animals, birds and fishes . . . with a description of . . . Siam. Written in High-Dutch . . . and translated . . . by J. G. Scheuchzer . . . with the life of the author and an introduction, etc. 2 vols. London, 1727. lii, 612, 75, 11 p. 45 pls. fol. Pre-Linn. 1727.1

Fishes, p. 34; 95–101. pls.
Various versions and editions follow.

—— Histoire naturelle . . . de l'empire du Japon . . . traduite en François sur la version Angloise de J. G. Scheuchzer. 2 vols. La Haye, 1729. illust. fol. Pre-Linn. 1729.1

Another French ed.: 3 vols. Amsterdam, 1732.

—— De beschryving van Japan . . . Uyt het Engelsch [of J. G. Scheuchzer] in 't Nederduytsch vertdalt. Amsterdam, 1729. 50, 500 p. 32 pls. 6 maps. fol. Pre-Linn. 1729.2

Also published in abbreviated form in Arkstee & Merkus, "Allg. Hist. Reisen," 1753, vol. XI; and in Pinkerton's Voyages, 1811, vol. VII.

Other eds. are: London (2nd English ed.), 1728; The Hague, 1729 (2 eds. French & Dutch), 1731 & 1732; Rostock, 1749 (German); Moscow, 1773 (Russian); Lemgo, 1774, 1777, 1779 (German).

The excellent English version of 1729 is available for present day readers as:

The history of Japan with a description of the kingdom of Siam, 1690–92 (J. G. Scheuchzer trans.) 3 vols. London, 1729. Reprinted by James McLehose & Sons, Glasgow, 1906.

The fishes of Japan with vernacular and Dutch names and 12 figs., vol. I, p. 217–235. Poisonous fishes, p. 217–222.

Kästner, *A. G.* (*translator*) [1719–1800] Kästner translated Kongliga Swenska Wetenskaps Academien Handlingar, 1739–1779, 40 vols., into German and published the series at Hamburg and Leipsic, 1749–1783, in 41 vols. under the title Der Königlicher Schwedischen Akademie Abhandlungen. Of the Nya Handlingar (1780–1812), he translated the issues for the years 1780–1790 and published them in 12 volumes at Leipsic in 1784–92, under the title Neue Abhandlungen, etc. This will explain why the same article appears in both Swedish and German.

Kalm, *Pehr* [1715–1779] P. Kalm's . . . Wästgôtha och Bohusländska resa. Förrättad år 1742. Med anmärkningar uti historia naturali, physique, medicine etc. Stockholm, 1746. iv, 304, 14 p. illust. 8°. Pre-Linn. 1746.1

Some fishes mentioned.

—— (*præses*) Enfalliga anmärkningar om Ost-Giötha Skäre Boars öfliga fiskesätt i Ostersjön. Inaug. Dissert. Abo, 1753. 46 p. 4°. Pre-Linn. 1753.1

Johannes Eliæson Enholm, *respond.*
Pisces, p. 8–20. A 2nd ed.: Abo, 1754. 28 p. 4°.

—— (*præses*). Dissertatio de causis diminutionis piscium. Aboæ, 1757, 9 p. 4°. Pre-Linn. 1757.1

Gust. Lindblad, *respond.*
For later works of P. Kalm, *see* in Vol. I.

Kamel, *George Joseph* [1661–1706] De piscibus, molluscis et crustaceis Philippensibus. Phil. Trans. Roy. Soc. London, 1705 (1706), **24**, 2043–2080. Pre-Linn. 1706.1

Kannegiesser, *Gottlieb Heinrich.* De cura piscium per Slesvici et Holsatiæ

ducatum usitata libellus. Kilonii, 1750. 130 p. 10 pls. 8°. Abstracts in Gel. Nachr. Hamburg. Corresp., 1751, 30. St. — Berlin Wochenbl., 1751, no. 22. — Erlang. Beytr., 1751, 253.
Pre-Linn. 1750.1

Kanold, *Joh.* [*c.*1679–1729] Von dem Fische Carcharias, oder See-Hunde. Samml. Nat. u. Med., Kunst u. Litt.-Gesch. Breslau, 1721, 16. sec., 635.
Pre-Linn. 1721.1

Katzbeccius, *George* (*respond.*) Dissertatio de jure thesaurorum inveniendorum, deque respiratione piscium, testatorum, crustatorum, mollium et insectorum. Coburg, 1609. 4°.
Pre-Linn. 1609.1

Andreas Libavius, *præses*.

Keill, *James* [1673–1719] A practical treatise upon angling with small and great rode, shewing the different flies and baits through the various seasons of the year; to which is adjoined fishing in ponds. Edinburg, 1729. 16 p. 8°.
Pre-Linn. 1729.1

Kentmann, *Johannes* [1518–1574] For comments on the work of this author as the oldest student of fossil fishes, *see* Zaunick, Rudolph. "Fragmente der ältesten sächsischen Fischfauna des Dr. Johannes Kentmann (1518–1574)." Abh. Naturwiss. u. Entwick. Ges. Isis, Dresden, 1915, p. 15–36.

—— Nomenclaturæ rerum fossilium que in Misnia præcipue, & in aliis quoque regionibus inveniuntur. (In Gesner, C. De omne rerum fossilium genere, gemmis, lapidibus, metallis, etc. Tiguri, 1565)
Pre-Linn. 1565.1

On folio 31 is the earliest known description of "Glossopetræ," fossil sharks' teeth; on folio 32, a reference to fossil fish scales.

Keogh, *J.* Zoologia medicinalis Hibernica: or, a treatise of birds, beasts, fishes, reptiles or insects, which are commonly known and propagated in this kingdom: giving an account of their medicinal virtues, and their names in English, Irish, and Latin. Dublin, 1739. xvi, 167, 9 p. 8°.
Pre-Linn. 1739.1

Keyens, *Otto.* Het waere onderscheyt tusschen konde en warme landen, etc. s' Gravenhage, 1659.
Pre-Linn. 1659.1

The original Dutch ed. A German version is:

—— Kurtzer Entwurff von Neu-Niederland und Guajana einander entgegen gesetzt, umb den Unterschied zwischen warmen und kalten Landen herausz zu bringen, u.s.w. Leipzig, 1672. 4°.
Pre-Linn. 1672.1

Fishes, p. 27–29, 59–62, 114.

Khraisser, *Sabastian.* Jus venandi, aucupandi et piscandi, Romano-Bavaricum, etc. Neoburgi ad Istrum, 1651. viii, 138, xxii p. 16°.
Pre-Linn. 1651.1

Kiranus, —— Kiranides, & ad eas Rhyakini Koronides, quorum ille in quaternario tam librorum quam elementari e totidem linguis, primo de gemmis XXIV, herbis XXIV, avibus XXIV, ac piscibus XXIV quadrifariam semper & fere mixtim ad tetrapharmacum constituendum agit: In libro II de animalibus XL; in lib. III de avibus XLIV sigillatim, & in lib. IV de LXXIV piscibus iterum, eorumque viribus medicamentosis. Lipsiæ, 1638. 12°.
Pre-Linn. 1638.1

Not seen. Very rare. Title from Gronovius. Kiranus, king of Persia, described in Arabic certain fishes. This book was translated into Greek, and finally into Latin as above. A later ed. is:

—— Mysteria physico medica, de lapidibus, piscibus, herbis, volucribus. Frankfort, 1681. 12°.
Pre-Linn. 1681.1

—— The magick of Kirani, King of Persia; and of Harpocration. London, 1685. 8°.
Pre-Linn. 1685.1

An English version of the preceding.

Kircher, *Athanasius* [1601–1680] For a sketch of this learned Jesuit, *see* Walsh, J. J. "Father Kircher, — scientist, orientalist and collector." Eccles. Review, Philadelphia, 1904, **31**, 459–474.

—— Magnes, sive De arte magnetica; opus tripartitum, quo præterquam quod universa magnetis natura, eiusque in omnibus artibus et scientiis usus nova methodo explicetur, e viribus quoque et prodigiosis effectibus magneticarum, aliarumq, etc. Coloniæ Agrippinæ, 1643. 797 p. & index. 8°.
Pre-Linn. 1643.1

Lib. III, pars VI, p. 657–677, De magnetica facultate, sive magnetismo animalium. Caput 2, sect. 1, Magnetismus bufonis et mustelæ. Sect. 3, De echeinidis seu remoræ, aliarumque marinarum animalium magnetismus. Sect. 4, De torpedinis magnetismo. Sect. 5, De magnetismo *Ranæ piscatricis*. Sect. 6, De magnete Æolio, seu quod idem est, de physa, seu orbe pisce Ægyptiaco.

The 2nd ed.; 1st: Rome, 1641: others: Cologne, 1642; Rome, 1654 & 1674.

Kircher, *A.*

—— Magneticum naturæ regnum, sive disceptatio physiologica de triplici in natura rerum magnete, etc. Amstelodami, 1667. 201 p. 12°.
Pre-Linn. 1667.1

Sectio iv, Caput 1, De magneto Æolio, sive ventorum demonstratore [Describes a fish called "Voladores"] Caput 2, Quomodo magnetismus inter mustelam et bufonem, remoræ et torpedinis intelligendus sit. Caput 3, De magnete navium, quæ remora seu echeneis dicitur. Caput 4, Alius magnes in certa conchyliorum specie noviter detecta torpedinis vim habens.

—— Mundus subterraneus in xii libros digestus, etc. 2 vols. Amstelodami, 1678. fol. Pre-Linn. 1678.1

Fossil fishes, vol. II, p. 37–38, figs.; 41–42. Monoceros (Xiphias), pp. 56–67. Fossil fishes, p. 91–94.

2nd ed.: 1st., Amsterdam, 1664–65. Dutch version, "Onderaardsche Weerelt," etc., Amsterdam, 1682. An abbreviated ed.: "Synopsis mundi subterranei," Herbipoli, 1660. 4°. Copy 1678 ed., N. Y. P.

—— Romani Collegii Societatis Jesu Musæum celeberrimum, cujus magnum antiquariæ rei, statuarum, imaginum, picturarumque partem. Ex Legato Alphonsi Donini . . . Amstelodami, 1678. 66 p. fol. Pre-Linn. 1678.2

Volador, Xiphias, Raja, Torpedo, briefly described p. 23–35.

Kircher, *J.* Jocoseriorum naturæ et artis, das ist: 300 nützliche und lüstige Sätze aus der Kunst und Natur, oder natürliche Magie. Bamberg, 1677. 4°.
Pre-Linn. 1677.1

"Bevat ook visscherij-geheimen." — Bosgoed

Kirchmaier, —— (*respond.*) Dissertatio de magno pisce, qui Jonam vatem deglutivit. Wittembergæ, 1705. 2 pl. 4°. Abstract in Nouv. Liter. German. Hamburg, 1705, 447.
Pre-Linn. 1705.1

"Carchariam fuisse asserit."
Joh. Frid. Hertenstein, *præses.*

Klein, *Jacob Theodore* [1685–1759] Historiæ naturalis piscium promovendæ missus V, cum præfatione de piscium auditu. 5 parts [in 1 vol.] Gedani, 1740–1749. 54 pls. gr. 4°.
Pre-Linn. 1740.1

i. De lapillis eorumque numero in craniis piscium, cum præfatione: de piscium auditu. Accesserunt . . . Observata in capite Raiæ. 1740. 36 p. 6 pls.

ii. De piscibus per pulmones spirantibus ad iustum numerum et ordinem redigendis. Accesserunt singularia: de . . . Lapide Manati et Tiburonis . . . 1741. 38 p. 6 pls.

iii. De piscibus per branchias occultas spirantibus ad justum numerum et ordinem redigendis. Cum observationibus circa partes genitales Rajæ maris, et ovarium Galei. 1742. 48 p. 7 pls.

iv. De piscibus per branchias apertas spirantibus ad justum numerum et ordinem redigendis. Horum series prima cum additamento ad missum tertium. 1744. 68 p. 15 pls.

v. De piscibus per branchias apertas spirantibus. Horum series secunda cum additionibus ad missus II, III, IV, et epistola: de cornu piscis carinæ navis impacto. 1749. 102 p. 20 pls.

"A remarkable work. It perhaps surpasses all other ichthyological publications in incongruities between the definitions of groups and the contents thereof, and it is difficult to conceive how some could have originated. The definitions themselves are sufficiently clear, and their practical application to forms would not appear to be difficult; the author however seems to have practically ignored his definitions of groups when once framed, and to have proceeded, as some more modern naturalists have done, by successive approximations of other forms to the types of his definitions, and without checking the results by subsequent comparison with the latter." — T. N. Gill, Smithson. Misc. Colls., 1872 (1874), **11**, no. 247, p. 29. For a contemporary review of the above work of Klein, *see* Eames, John, in this section.

2nd ed.: Leipsic, 1802. (Klein, J., 1802.1.)

—— Mantissa ichthyologica de sono et auditu piscium; sive, Disquisitio rationum, quibus autor epistolæ in bibliotheca gallica de auditu piscium, omnes pisces mutos surdosque esse, contendit. Lipsiæ, 1746. 4, 30 p. 4°.
Pre-Linn. 1746.1

The letter referred to was published in the Bibliothèque Françoise, tom. XXXVI, pt. ii, p. 273, etc. An abstract in English is found in Phil. Trans. Roy. Soc. London, **45**, p. 233. *See* Brockelsby, R., 1750.1, this section.

—— Dass Fische weder stumm noch taub sind. Abh. Nat. Ges. Danzig, 1747, 1. Th., 106–143.
Pre-Linn. 1747.1

For other papers by this author and for later editions of the above, *see* Klein, J. T., in vol. I.

Knorr, *George Wollfang* [1705–1761] Deliciæ naturæ selectæ, oder auserlesenes Naturalien-Cabinet, welches auch den drey Reichen der Natur zeiget was, von Curiosen Liebhabern aufbehalten und gesammelt zu werden verdienet. Nürnberg, 1754. pls. fol.
Pre-Linn. 1754.1

For a second and enlarged ed., *see* Knorr, G. W., 1766.1. Other eds. are: Nürnberg, 1776, 1777 & 1778; Dordrecht, 1771 (Dutch), & Amsterdam, 1773.

—— Sammlung von Merkwürdigkeiten der Natur und Alterthümern des Erdbodens, welche petrificirte Körper enthält. Lapides diluvii testes, quos in ordines et species distribuit, suis coloribus exprimit, ærique incisos in lucem mittit Knorr. Noribergæ, 1755. figs. fol. Pre-Linn. 1755.1

For later eds., *see*, Knorr, G. W., 1775.1, & Knorr & Walch, 1768.1.

Knox, *Robert* [c. 1640–1720] An historical relation of the island of Ceylon in the East Indies, with an account of his escape from captivity. London, 1681. pls. map. portr. fol.
Pre-Linn. 1681.1

Fishes and fishing, pp. 27–29. fig.
The 1st ed. Others are: Paris & Lyons, 1664 (French); Leipsic, 1681, 1684, 1689 (German); Amsterdam, 1693 (French), and a Dutch version as follows:

—— 't Eyland Ceylon in sijn binnenste, of 't Koningrijck Candy geopent, en nauwkeuriger dan oyt te vooren ontdeckt; vertaeld door S. de Vries. Utrecht, 1692. pls. map. 4°.
Pre-Linn. 1692.1

Fishes, pp. 39, 40, 58.
Under the heading "Reise nach Ostindien [Ceylon, 1657–1659]" it was reprinted in Arkstee & Merkus, Allg. Hist. Reisen, 1751, Bd. VIII. But it is most available for the English reader in the fine verbatim reprint issued by MacLehose at Glasgow, 1911, concerning which the following notes are added: "It was first printed by Richard Chiswell, 1681, and was reprinted by Harris, who translated it into French, Dutch and German. The present reprint not only reproduces the original text and the quaint original woodcuts, but also adds a hitherto unpublished autobiography and other notes which were discovered by the late Mr. Donald Ferguson in manuscript, bound up with a copy of the 'Historical relation of Ceylon' in the Bodleian Library."

Knutberg, *Carl.* Erfindung Seehunde zu fangen. K. Svensk. Vetensk. Akad. Handl., 1755, **16**.
Pre-Linn. 1755.1

Koenig, *Emanuel* [1658–1731] Regnum animale sectionibus tribus physice, medice, harmonice, mechanice, theoretice, practice evisceratum, enumeratum & emedullatum; hominis scilicet & brutorum mechanicam hydraulico-pneumaticam comparate, item quinque classes universales ac usum cibarium & medicinalem curiosis quibusvis proponens. Coloniæ, 1682. 4°.
Pre-Linn. 1682.1

According to Agassiz, there was a simultaneous issue at Basel, 1682. Other eds. are: Basel, 1688 & 1692; Cologne, 1698 — the latter much augmented.
The 1692 ed. (in N. Y. P.) contains 192 pages and has fishes, their parts and uses; pp. 12, 19, 38, 110–112; their uses in medicine, pp. 153–155.

—— Lupi piscis et mugilis ventriculi conformatio. Ephemer. Acad. Nat. Cur., 1686 (1687), dec. 2, ann. 5, 208–209.
Pre-Linn. 1687.1

—— De glossopetris in Helvetia repertis. Ephemer. Acad. Nat. Cur., 1689 (1690), dec. 2, an. 8, 303.
Pre-Linn. 1690.1

—— De ranæ piscatricis anatome [Lophius]. Ephemer. Acad. Nat. Cur., 1694 (1695), dec. 3, an. 2, 204–207.
Pre-Linn. 1695.1

The same is also included in Valentini, M. B. "Amphitheatrum Zootomicum," 1720, pt. II, pp. 134–135.

Koenig, *Samuel Fridericus.* Dissertatio inauguralis de lamia Plinii, etc. Argentorati, 1742. iv, 20 p. pls.
Pre-Linn. 1742.1

Lamia, a kind of flat fish. *See* Pliny, "Natural history of animals," 9, 24, 40.

Kolbe, *Peter* [1675–1726] For a biography, *see* sketch by Oertel, Georg Christian. Neustad, 1758. 4°, and a review of the same in Erlangen Gelehrt. Anmerk., 1758, 195.

—— Caput Bonæ Spei hodiernum, Das ist vollständige Beschreibung des afrikanischen Vorgebirges der Guten Hoffnung, worinnen abgehandelt wird, wie es heut zu Tage nach seiner Situation und Eigenschaft aussieht, ingleichen was ein Naturforscher in den drei Reichen der Natur daselbst findet, etc. 3 parts [in 1 vol.] Nürnberg, 1719. 26 pls. fol.
Pre-Linn. 1719.1

Versions in other languages follow.

—— Naauwkeurige beschryving van de Kaap de Goede Hoop; behelzende een geleerde beschryving van deszelfs dieren, visschen, vogelen, enz. Amsterdam, 1727. 2 vols. fol.
Pre-Linn. 1727.1

—— The present state of the Cape of Good Hope, etc. 2 vols. London, 1731. pls.
Pre-Linn. 1731.1

Vol. I. Hottentot manner of fishing, pp. 256–259. Vol. II. "Sea and river fish at the Cape of Good Hope," pp. 186–208. pls. viii & ix.
Other eds.: 1735 & 1738.

—— Description du Cap Bon Espérance. 3 vols. Amsterdam, 1741–43.
Pre-Linn. 1741.1

—— Beschreibung des Vorgebürges der Guten Hoffnung und derer darauf wohnenden Hottentoten. Frankfurt & Leipzig, 1745. 4°.
Pre-Linn. 1745.1

Koleffel, *Matthias Jacobus* (*respond.*) Disputatio juridica de piscatione . . . M. J. Koleffel, Ravenspurgensis, auctor et respondens. Basil, [1684]. 48 p. 6 pls. 4°.
Pre-Linn. 1684.1

Jacob Burckhard, *præses.*

Konrad of Megenberg (*Canon of Regensburg*) [1309–1378] Das Register . . . Hye nach volget das Puch der

Konrad of Megenberg. Natur . . . Welches Puch Meister Cunrat von Megenberg von Latein in Teutsch transzferiet und geschriben hat. Augsburg, 1475. 292 leaves. 12 woodcuts. sm. fol. Pre-Linn. 1475.1

Sec. xii, pt. v, contains fishes.
First ed. (copy, J. P. M.). Others: Augsburg, 1478, 1481, 1482 (2 separate printings by different printers), 1489, 1499; Frankfort, 1536 & 1540; Leipsic, 1505; Venice, 1508; Turin (Italian), 1508.
The best eds. probably are:

—— Naturbuch von Nutz, Eigenschaft, Wunder, Würkung und Gebrauch aller Geschöpfe, Element und Creaturen. Augspurg, 1489. fol. Pre-Linn. 1489.1

—— Das Buch der Natur . . . Wöliches Buch Meyster Cunrat von Megenberg von Latein in Teutsch transzferieret und geschriben hat. Augsburg, 1499. 171 leaves. 14 woodcuts. sm. fol. Pre-Linn.1499.1

For modern German versions, *see:*

Konrad of Megenberg Das Buch der Natur herausgegeben von F. Pfeiffer. Stuttgart, 1861.

Das Buch der Natur von Konrad von Megenberg. Eine Ausgabe in moderner Sprache. [Hugo Schulz, editor] Stuttgart, 1897.
Fishes treated & figured in books v & vi.

The compiler of "Das Buch der Natur" is generally conceded to have been Konrad, Canon of Regensburg. The real author is unknown, but his work was written in Latin and translated into German by Konrad in the year 1349. The authorship of the Latin original has been attributed to Albertus Magnus (1193–1280), and to Thomas Cantipratensis (1186-1263). Since Albert is quoted freely in the book, he could hardly have been its author. Nor does it seem that it can be attributed to Thomas whose compilation, "De rerum natura libri XX," is quite unlike it. It is probable that the German translator of the Latin original did not know the name of the compiler.
For a critical survey of the authorship and contents of the "Buch der Natur" *see* Choulant, L. "Graphische Incunabeln für Naturgeschichte und Medicin . . . des XV u. XVI Jahrhunderts." Leipzig, 1858, pp. 99–122. The same author discusses the authorship in: "Die Anfänge wissenschaftlicher Naturgeschichte und naturhistorischer Abbildung im christlichen Abendlände." Dresden, 1856. For reference to codices of "Das Buch der Natur," *see* Miller, C. 1897.1.

Kornmann, *H.* Templum naturæ historicum, in quo de naturâ et miraculis elementorum ità disseritur, ut nihil de rerum principiis, ignis naturâ, animalibus igneis, pyromanteiâ, animalibus aëreis, avibus, etc., de aqua, piscibus, maribus, fluminibus, de terrâ, animalibus terræ, etc. Lipsiæ, 1666. 8°. Pre-Linn. 1666.1

Also in his "Operibus eius curiosis." Francofurti, 1696. 8°.

Kozack, *Jno. Sophronius* [1603–1685] Mica I^a philosophiæ sacræ; oder Beschreibung der Geschöpfe des fünften Tages, nämlich der Fische und Vögel. Bremen, 1662. 8°. Pre-Linn. 1662.1

Kramer, *Wilhelm Heinrich.* Elenchus vegetabilium et animalium per Austriam inferiorum observatorum, sistens ea in classes et ordines, genera et species redacta. Viennæ, Pragæ & Tergesti, 1756. pl. 8°. Pre-Linn. 1756.1

Thirty-eight fishes are described.

Kraut, *George* [*fl.* 16th cent.] Experimentarius medicinæ. Argentinæ, 1544. fol. Pre-Linn. 1544.1

Deals with fishes in medicine among other things, according to Walbaum.

Kräutermann, *Valentin.* Compendieuses lexicon exoticorum et materialium, oder Beschreibung derer vornehmsten ausländischen Ost- und West-Indianischen Materialien und Vegetabilien, ingleichen derer Fossilen, Metallen, wie auch aller ausländischen Thiere, Fische, und Vögel &c. Arnstadt, 1730. 552 p. 8°. Pre-Linn. 1730.1

Kreysig, *George Christoph* [1697–1758] For a sketch of his life, *see* Dresden. Gel. Anz., 1758, 379.

—— Bibliotheca scriptorum venaticorum, continens auctores, qui de venatione, sylvis, aucupio, piscatura, et aliis eo spectantibus, commentati sunt. Altenburgi, 1750. 8°. Pre-Linn. 1750.1

Kronland, *J. M. M. de.* For a biographical sketch, *see* Láska, Václav. "Ueber Marcus Marci de Kronland." Zeitschr. Math. Phys., 1890, (*Hist.-lit. Abth.*), **35**, 1–3.

—— Philosophia vetus restituta, in quâ de statu hominis secundum naturam agitur. Francofurti, & Lipsiæ, 1676. 4°. Pre-Linn. 1676.1

"De pisce echeneide, qua ratione navigia sistat," p. 574–580.

Kulmus, *Joannes Adamus* [1689–1745] Von dem Wasser- oder Fisch-Käfer, als einem bisher unbekannten Fisch-Räuber. Samml. Nat. u. Med., Kunst u. Litt.-Gesch. Breslau, 1719, 10. sect., 593. Pre-Linn. 1719.1

—— Von einen gewissen Fisch-Insecto (Ephemera) Samml. Nat. u. Med. Kunst u. Litt.-Gesch. Breslau, 1723. 23. sect., art. 4, 292. Pre-Linn. 1723.1

Kundmann, *Johann Christian.* Rariora naturæ et artis. 1737. Pre-Linn. 1737.1

Measurement of *Carcharodon megalodon* estimated on basis of size of tooth, p. 86–91.

L

Laan, *Adrian van der* (*engraver*) [1684–1755] Groote vissery. Amsterdam, [*c.* 1700] 4°. Pre-Linn. 1700.1

Contains 16 engravings by Adrian van de Laan, from drawings by van der Meulen and others (all relating to the herring fishery).

Labat, *Jean Baptiste* [1663–1738] Nouveau voyage aux isles de l'Amérique, contenant l'histoire naturelle de ces pays, . . . avec une description exacte & curieuse de toutes ces isles . . . 6 vols. Paris, 1722. illust. 12°. Pre-Linn. 1722.1

—— Nieuwe reizen naar de Franse eilanden van America, etc. 3 vols. Amsterdam, 1725. Pre-Linn. 1725.1

Later editions and translations are those of Paris, 1726, 1728, 1738, 1742; The Hague, 1724, 1738; Amsterdam (Dutch), 1722 & 1725; & Nuremberg (German), 1782–87.

—— Nouvelle relation de l'Afrique occidentale: contenant une description exacte du Sénégal et des pays situés entre le Cap-Blanc et la rivière de Serrelionne . . . l'histoire naturelle de ces pays, etc. 5 vols. Paris, 1728. illust. 12°. Pre-Linn. 1728.1

Other eds. are: Paris, 1732 & 1758. Found also in Arkstee & Merkus. Allg. Hist. Reisen. Bd. III, as "Beschreibung Sierra Leona," etc., 1748.

—— Voyage du Chevalier des Marchais en Guinée, isles voisines et à Cayenne, fait en 1725, 1726, & 1727. 4 vols. Paris, 1730. Pre-Linn. 1730.1

Vol. III, chap. x, marine and freshwater fishes described.
Another ed.: 1731.

—— Nouveau voyage aux isles de l'Amérique, contenant l'histoire naturelle de ces pays . . . Nouvelle édition augmenté considérablement, & enrichie de figures, etc. 8 vols. Paris, 1742. 12°. Pre-Linn. 1742.1

This, the best ed. of Labat's "Nouveau Voyage," is the most copious work of the time that we possess on the Antilles. It is very full on the natural history of these islands.

La Chambre, *Fr. de,* & **Baralis,** *B.* *See* **Baralis & La Chambre.**

La Chesnaye Desbois, *François Alexandre Aubert de* [1699–1784] Dictionnaire universel d'agriculture et de jardinage, de fauconnerie, chasse, pêche, etc. 2 vols. Paris, 1751. 4°. Pre-Linn. 1751.1

—— Système naturel du règne animal, par classes, familles ou ordres, genres et espèces avec une notice de tous les animaux; les noms Grecs, Latins, & vulgaires, que les naturalistes leur ont donnés; les citations des auteurs qui en ont écris . . . suivant la méthode de M. Klein; avec une notice de celle de M. Linnæus . . . & l'ordre poissons suivant la division de l'Artedi. 2 vols. Paris, 1754. 8°. Pre-Linn. 1754.1

Poissons, vol. I, p. 247–338. pl.
This work was published anonymously and has, by Engelmann and other bibliographers, been ascribed to M. J. Brisson, being confused with a work by this author bearing nearly similar title (*see* Brisson, M. J., Pre-Linn. 1754.1). However, it is now known to have been written by La Chesnaye Desbois, who has led to much confusion by publishing almost all his works anonymously. Copy vol. I, A. M. N. H.

Laet, *Jan de* [1593–1649] Nieuwe Wereldt ofte beschrybinghe van West-Indien, wt veelerhande schriften ende aanteekeningen van verscheyden natien by een versamelt. Door Ioannes de Laet, ende met noodighe kaerten ende tafels voorsien. Leyden, 1625. xxii, 526 p. maps. fol. Pre-Linn. 1625.1

"See Asher's 'Essay,' no. 1. This invaluable work was much improved in the subsequent editions and translations by the author, but the maps were unchanged."—Sabin, Bibl. Amer., 1878, XX, 15.
This is the rare 1st ed. The 2nd was issued at Leyden, also by Elzevir, in folio, 1630. Translations into various languages follow in chronological order.

—— Novus orbis seu descriptionis Indiæ Occidentalis Libri XVIII. Authore Joanne de Laet Antwerp. Novis tabulis geographicis et variis animantium, plantarum fructuumque iconibus illustrati. Lugduni Batavorum, 1633. 690 p. maps & cuts. Pre-Linn. 1633.1

"At p. 570 is found a chapter dealing with the fishes of Brasil, extracted from MS. sources." C. & V.

—— L'histoire du nouveau monde ou description des Indes Occidentales, contenant dix-huict livres, par le Sieur

Laet, *J.*
Jean de Laet, d'Anvers; enrichi de nouvelles tables géographiques & figures des animaux, plantes & fruicts. Leyde, 1640. 632 p. fol. Pre-Linn. 1640.1

—— Historie ofte jaerlicjck verhael van de verrichtingen der . . . West-Indische Compagnie, zedert haer begin [1623] tot het eynde van 't jaer 1636. Leyden, 1644. xxxii, 544, 31 p. pls. maps. fol. Pre-Linn. 1644.1

—— (*editor*) Historia naturalis Brasiliæ, etc. Joannes de Laet in ordinem digessit et annotationes addidit & varia ab auctore omissa supplevit & illustravit. Lugduni Batavorum et Amstelodami, 1648. sect. i, 122 p. sect. ii, 292 p. figs. fol. Pre-Linn. 1648.1

The first section of this volume is composed of William Piso's "De medicina Brasiliensi," comprising four books. The second section is composed of George Marcgrave's "Historiæ rerum naturalium Brasiliæ." This latter, Laet found left in cipher by Marcgrave. He translated the cipher, added notes of his own (set in separately) and edited the whole work.

Cuvier & Valenciennes thus characterized Laet: "Directeur de la Compagnie Hollandaise des Indes Occidentales, grand promoteur de la géographie, éditeur de Margrave et auteur de plusieurs oeuvres."

Laet, *S. V.* Voyagien naa en door het groot en magtigt Koninkryk van Persien . . . Begrijpende en verhandelende . . . vissen, etc. Amsterdam, 1667. 4, 128 p. sm. 4°. Pre-Linn. 1667.1

Credited by P. A. Tiele to Jan de Laet.

La Hontan, (*Baron*) *Jean de* [*c.* 1666–1715] Nouveaux voyages dans l'Amérique septentrionale. 2 vols. La Haye, 1702. 12°. Pre-Linn. 1702.1

Other eds. are: The Hague, 1703, 1705, 1709, 1715, 1739; Amsterdam, 1728 & 1731; Hamburg & Leipzig, 1709, 1711. An English ed. is:

—— New voyages to North America. 2 vols. London, 1703. 1, 280 p. 12 maps. cuts. Pre-Linn. 1703.1

Vol. I, p. 243–247 gives a list of the fish of the river St. Lawrence.

La Hontan's travels were reproduced in Arkstee & Merkus, Allg. Hist. Reisen, 1758, Bd. XVI, under the title "Reise . . . auf dem langen Flusse (1688)"; also in Pinkerton's Collection of Voyages, 1812, vol. XIII.

Lambach, *Hier.* Consilium medicum, quo Raphani usus arguitur, leporis caro approbatur, nec non halecis recentissimi salubritas confirmatur. Hamburg, 1603. 8°. Pre-Linn. 1603.1

Lambertus Audomarensis (*St. Omer*) Liber floridus. MS. *c.* 1077. Pre-Linn. 1077.1

Chapter LII, "De monstris marinis et piscibus."

This is a general digest of knowledge, historical, ecclesiastical and natural, taken from many writers. An account of it is given in Migne, **163**, col. 1004 sqq. It is a predecessor of the "Speculum" of Vincent de Beauvais.

For brief data about the man and his work, descriptions of the extant MS. copies, and a list of chapter headings of his encyclopædia, *see:* Zacher, J. Lamberti Floridus. Serapeum für Bibliothekwissenschaft, Handschriftenkunde und ältere Literatur. Leipzig, 1842, 3. Jahrg., 145–154; 161–172.

Lamorier, *L.* Sur un organe particulier du chien de mer. Mém. Acad. Sci. Paris, 1742 (1745), hist., 32–33. Pre-Linn. 1745.1

Langius, *Christ.* Anguilla, cœnarum helena. (In his Curiosis Medicis, Frankfort, 1688, 4°.) Pre-Linn. 1688.1

—— Vom Aalfange in Preussen. Samml. Nat. u. Med., Kunst u. Litt.-Gesch. Breslau, 1719, 4. Vers., 1223. Pre-Linn. 1719.1

La Nux, —— *de.* Observation sur un poisson qui file une espèce de soie dans laquelle il se renferme avec ses œufs. Mém. Acad. Sci. Paris, 1755, hist., 39–40. Pre-Linn. 1755.1

La Roque, —*Abbé de.* De pisce remora . . . & de dentibus canis marini (In Zodiacus medico-gallicus, sive miscellaneorum curiosorum medico-physicorum sylloge continens celeberrimorum virorum tum medicorum aliorumque eruditorum in Gallia observationes, tum opuscula medica & physica Gallice emissa, & Latinitate donata. Geneva, 1682, 4, 92.) Pre-Linn. 1682.1

Lawson, *John.* A new voyage to Carolina; containing the exact description and natural history of that country: By John Lawson, Gent. Surveyor-General of North Carolina. London, 1709. 258 p. pl. map. fol. Pre-Linn. 1709.1

Fishes, marine and freshwater, of North Carolina, p. 152–163.

This is next found in Stevens' "Collection of Voyages," London, 1711. A German version is:

—— Allerneuste Beschreibung der Provinz Carolina in West-Indien. Samt einem Reise-Journal von mehr als Tausend Meilen unter allerhand Indianischen Nationen. Auch einer accuraten Land-Carte und andern Kupfer-Stichen. Aus dem Englischen übersetzt. Hamburg, 1712. 7, 365 p. sm. 8°. Pre-Linn. 1712.1

Fishes. p. 232–250.

Another German ed.: 1722; other English issues (reprints 1st ed.): London, 1714 & 1718. American reprints: Raleigh, N. C., 1860; Charlotte, N. C., 1903 (verbatim).

Lawson, *or* **Lauson,** *William* [*fl.* 1618] Editor of various editions of John Denny's " The secrets of angling." (*q. v.*)

Lebrun, *Corneille*. *See* **Bruyn,** *Cornelius de.*

Le Comte, *Louis* [*c.* 1650–1729] Beschryvinge van het machtige keyserryk China, behelsende d'overgroote provintien en menigvuldige steden, paleysen, rivieren; . . . etc. 2 vols. [in 1] The Hague, 1698. 398 p. figs. 4°. Pre-Linn. 1698.1

Gout-en silvervisschen, p. 89–91. Wonderlijke visschen, p. 376–383.
Original French ed.: Paris, 1696–97; another (3rd): Paris, 1698.

Ledel, *Sam.* [1644–1717] Carpiones diu viventes. Ephemer. Acad. Nat. Cur., 1691 (1692), 2. dec., ann. 10, 28–29. Pre-Linn. 1692.1

Leeuwenhoek, *Antony van* [1632–1723] For biographical notices, *see*: Miall, L. C. The Early Naturalists. London, 1912. p. 200–223: Locy, William A. Biology and its Makers. New York, 1908, p. 77–88, (portrait); Pop. Sci. Mo., April, 1901: Richardson, Disciples of Aesculapius, 1901, vol. II, p. 108; The Aesclepiad, 1885, vol. II. portrait, signature and other ills.

—— Ontledingen en ontdekkingen van levende dierkens in de teel-deelen van verschegd . . . visschen. Leyden, 1677. 4°. Pre-Linn. 1677.1

—— Ondervindingen en beschouwingen der onsigtbare geschapene waarheden, vervat in verscheydene brieven, geschreeven aan de wytberœmde Koninglyke Societeit in Engeland. Leidæ, 1684. pls. 4°. Pre-Linn. 1684.1

In this collection of papers there are several dealing with fishes.

—— Ondervindingen over het maaksel van't humor crystallinus son van verscheyde dieren, vogelen, ende visschen, het draad-agtig wesen dat in 'toog voet komt, enz. Leyden, 1684. 4°. Pre-Linn. 1684.2

—— Abstract of a letter . . . concerning the scales of eels. Phil. Trans. Roy. Soc. London, 1685 (1686), **15**, 893–895. Pre-Linn. 1686.1

—— Ontleedingen & ondekkingen van levenden dierkens in de teel deelen van verscheyden dieren, vogeln en visschen: van het hout met desselven menigvaldigen natur. Leiden, 1686. 4°. Pre-Linn. 1686.2

—— Anatomia & interiora rerum. Leidæ, 1687. 4°. Pre-Linn. 1687.1

Structure and flesh of fish. 2nd ed.: Leidæ, 1696. 4°.

—— Natuurs verborgentheden ondekt, zynde een tweede vervolg der brieven geschreeven aan de Koninglyke Societeit tot London. Delphis Batavorum [Delft], 1689. pls. 4°. Pre-Linn. 1689.1

Contains data on structures of fishes.

—— Ontledingen en ontdekkingen van onsigtbare verborgentheden. Leiden, 1691. figs. 4°. Pre-Linn. 1691.1

Contains data about the reproduction of fishes, and about the scales of eels.

—— An extract of a letter . . . containing observations on . . . the gall, and scales of fishes . . . Phil. Trans. Roy. Soc. London, 1693 (1694), **17**, 956–958. Pre-Linn. 1694.1

—— Vierde vervolg der brieven geschreven aan de wytvermaarde Koninglyke Societeit in London. Delphis Batavorum [Delft], 1694. figs. 4°. Pre-Linn. 1694.2

Contains data on reproduction of fishes.

—— Arcana naturæ detecta. Delft, 1695. 4°. Pre-Linn. 1695.1

Reprints of letters to Royal Society of London dealing with reproduction and with circulation of blood in fish.
Second ed.: Leiden, 1722, 4°.

—— Extract of a letter containing microscopical observations on eels, etc. Phil. Trans. Roy. Soc. London, 1696, **19**, 269–280. Pre-Linn. 1696.1

Sexes and reproduction of eels, and circulation of blood in tails of eels.

—— Continuatio arcanorum naturæ detectorum. Delft, 1697. 4°. Pre-Linn. 1697.1

Sexes of eels, circulation in eels, and scales of fishes.
2nd ed.: Leidæ, 1722. 4°.

—— Sesde vervolg der brieven geschreeven aan verscheiden hooge standspersonen en geleerde luyden. Delphis Batavorum [Delft], 1697. figs. Pre-Linn. 1697.2

Contains data about various fishes.

—— Letter concerning the spawn of codfish. Phil. Trans. Roy. Soc. London, 1701 (1702), **22**, 821–824. Pre-Linn. 1702.1

Leeuwenhoek, *A. v.*

—— Part of a letter from Mr. Lewenhoek, concerning the circulation and globules of the blood in butts. Phil. Trans. Roy. Soc. London, 1700 (1702), **22**, 552–560. Pre-Linn. 1702.2

—— A letter from Mr. Antony van Leeuwenhoek, F. R. S., concerning the flesh of whales, crystaline humour of the eye of whales, fish and other creatures, and of the use of the eye-lids. Phil. Trans. Roy. Soc. London, 1704 (1706), **24**, 1723–1730. Pre-Linn. 1706.1

—— On the circulation of the blood in fishes. Phil. Trans. Roy. Soc. London, 1708 (1709), **26**, 250. Pre-Linn. 1709.1

—— On the circulation of the blood in an eel. Phil. Trans. Roy. Soc. London, 1708 (1709), **26**, 448–449. Pre-Linn. 1709.2

—— Epistolæ ad Societatem Reg. Anglicanam & alios viros illustres datæ, seu continuatio mirandorum arcanorum naturæ detectorum XL epistolis contentorum. Lugduni, 1719. 4°. Pre-Linn. 1719.1

"Quædam de acipensere, gado, anguillæ & harengi generatione & de squamarum piscium incremento ibi explicantur." — Walb.

—— Epistolæ physiologicæ. Delft, 1719. 4°. Pre-Linn. 1719.2

Scales of fishes.

—— Observations on the muscular fibres of fish. Philos. Trans. Roy. Soc. London, 1721 (1723), **31**, 190–198. Pre-Linn. 1723.1

—— A letter to the Royal Society concerning the particles of fat, translated from the Dutch by John Chamberlain. Phil. Trans. Roy. Soc. London, 1722 (1724), **32**, 93–99. Pre-Linn. 1724.1

Microscopic structure of the fat of the plaice and perch.

Two collections of Leeuwenhoek's works appeared before his death (1723); one in Dutch, Leiden & Delft, 1685–1718; the other in Latin, Leiden, 1715–1722. A selection from the latter, translated into English by S. Hoole, appeared at London, 1798–1807.

Le Grand, *Ant.* [–1699] Institutio philosophiæ secundum principia renati des cartes nova methodo exornata & explicata. Londinii, 1680. figs. 4°. Pre-Linn. 1680.1

—— Institutio philosophicæ. Norimbergæ, 1683. 856 p. 8°. Pre-Linn. 1683.1

Fishes, p. 398, 402, 520, 574–578. Copy, Col.

Leguat, *François* [1638–1735] Voyage et aventures de F. Leguat . . . en deux isles désertes des Indes orientales. Avec la rélation des choses les plus remarquables qu'ils ont observées dans l'isle Maurice, à Batavia, au cap de Bonne-Espérance, dans l'isle St. Hélène et en d'autres endroits de leur route. 2 vols. Londres, 1708. illust. 12°. Pre-Linn. 1708.1

Fishes: vol. I, p. 10–12, 20–25, 121–123; vol. II, p. 39–41. figs.

Other eds.: French, London, 1711, 1721; German, Frankfort & Leipsic, 1709. Dutch and English versions follow.

—— De gevaarlyke en zeldzame reyzen van den Heere F. L. mit zyn byhebbend gezelschap naar twee onbewoonde Oostindische eylanden. Utrecht, 1708. xvi, 178 p. 4°. Pre-Linn. 1708.2

—— A new voyage to the East-Indies by F. Leguat and his companions, etc. London, 1708. viii, xv, 248 p. pls. maps. 8°. Pre-Linn. 1708.3

Easily available as reprint, Hakluyt Soc., Works, nos. 82 & 83, 1891.

Lehmann, *Christian* [1611–1688] Historischer Schauplatz derer natürlichen Merkwürdigkeiten in den Meissnischen Ober-Ertzgebürge. Leipzig, 1699. fig. 4°. Pre-Linn. 1699.1

Describes the mammals, birds and fishes of this region.

Another ed.: Leipzig, 1747. 4°.

—— (*respond.*) De carne piscium dissertatio. Hafniæ, 1714. 8 p. 4°. Pre-Linn. 1714.1

Joh. Helsingius, *præses.*

Leigh, *Charles* [1662–*c.* 1701] The natural history of Lancashire, Cheshire, and the peak of Derbyshire, etc. Oxford & London, 1700. 25 pls. fol. map. Pre-Linn. 1700.1

Fishes, p. 130–147.

Le Maire, —— (*Sieur*) *de.* Les voyages aux îles Canaries, Cap-Verd, Sénégal, et Gambie. Paris, 1695. 8°. Pre-Linn. 1695.1

Much data about fishes.

There is a much abridged English version by Edmund Goldschmid, Edinburgh, 1887.

Le Marie, ——. Observation sur un poisson de mer des Indes, nommé lézard d'eau. Mém. Acad. Sci. Paris, 1751, hist., 36. Pre-Linn. 1751.1

Lemery, *Nicolas* [1645–1715] Modern curiosities of art and nature. Extracted out of the cabinets of the most eminent personages of the French court

. . . made English, from the original French. London, 1685. 12°.
Pre-Linn. 1685.1

Data on fish and fishing.
Another issue: London, 1711, translated from the 7th ed. (in French). Original not known.

Lemnius, *Levinus* [1505–1568] De occultis naturæ miraculis libri II. Antwerp, 1559. 12°. Pre-Linn. 1559.1

Some data on fishes,—remora & others.
The first issue of a work which ran through a large number of editions. Twenty-two of these are known, including 6 at Antwerp & 5 at Frankfort. Among them are versions in Italian (1560), Dutch (1588), German (1593), & English, 1658. Two of these are:

—— Occulta naturae miracula. Wunderbarliche Geheimnisse der Natur in des Menschen Leib und Seele, auch in vielen andern natürlichen Dingen, als Steinen, Ertzt, Gewächs und Thieren. Aus dem Latein in Teutsche Sprach gebracht, zum dritten Mal vermehrt, und eines grossen Theils vom Neuen selbst geschrieben durch Jacobum Horstium. Leipzig, 1593. 2 vols. 4°.
Pre-Linn. 1593.1

—— Concerning the secret miracles of nature. London, 1658.
Pre-Linn. 1658.1

Copy, L. C.

Léry, *Jean de* [1534–1611] Histoire d'un voyage faict en la terre du Brésil, autrement dite Amérique. Contenant la navigation, et choses remarquables, veües sur mer par l'aucteur . . . Les meurs et façons de vivre estranges des sauvages Amériquains, &c. Rouen, 1578. 8°. Pre-Linn. 1578.1

Contains (in pt. 12) earliest descriptions of Brazilian fishes.
The rare 1st ed. This work passed through eds. in French; Geneva, 1580, 1600, & 1611; La Rochelle, 1585; Paris, 1580, 1585, 1586, 1594 & 1600. Latin eds. are: Geneva, 1586 (1st), 1587, 1594, 1600, 1677; German, Frankfort, 1594. It was also reprinted in De Bry. America, pt. III. Latin, 1592; and in Arkstee & Merkus. Allg. Hist. Reisen, Bd. XVI. 1758. Extracts are also found in "Purchas his Pilgrimes." 1625, vol. IV, p. 1325.

—— Historia navigationis in Brasiliam, qua et America dicitur, qua describitur . . . Brasiliensium mores . . . cum eorum linguæ dialogo, animalia etiam, arbores atque herbæ, etc. Genevæ, 1586. pl. 8°. Pre-Linn. 1586.1

—— Historie van een reyse ghedaen in den lande van Bresillien, andersins ghenoemt America, etc. Amsterdam, 1597. 214 leaves. figs. 8°.
Pre-Linn. 1597.1

L'Escluse, *Charles*. *See* **Clusius,** *C.*

Le Tellier, *Pet.*, & **Ronaudot,** *Eus.* Non ergo licet citra sanitatis dispendium bis in piscibus satiari. Paris, 1639.
Pre-Linn. 1639.1

From Boehmer. Not seen.

Le Vasseur, *Claud*, & **Cousin,** *Jo.* *See* **Cousin** & **Le Vasseur.**

Leyser, *Aug.* De piscatione. Helmstadt, 1727. 4°. Pre-Linn. 1727.1

Lhuyd, *Edward*. *See* **Luid,** *Edward*.

Libavius, *Andreas* (*præses*) [*c.* 1560–1616] Dissertatio de jure thesaurorum inveniendorum, deque respiratione piscium, testatorum, crustatorum, mollium et insectorum. Coburg, 1609. 4°.
Pre-Linn. 1609.1

Georgius Katzbeccius, *respond.*

Lichtensteger, *G.*, & **Eisenberger,** *N. F.* *See* **Eisenberger** & **Lichtensteger** (*editors*).

Liger, *Louis* [1658–1717] Oeconomie générale de la campagne, ou nouvelle maison rustique. 2 vols. Paris, 1700. 4°. Pre-Linn. 1700.1

Other eds.: Paris, 1701 & 1708. Liger's work appears also as the following:

—— Amusemens de la campagne, ou, nouvelles ruses innocentes . . . avec les plus beaux secrets de la pêche dans les rivières et étangs; et un traité général de toutes les chasses. 2 vols. Paris, 1709. xx, 486 & viii, 518 p. illust. 12°.
Pre-Linn. 1709.1

Other editions appeared with varying titles containing essentially the same material. Some follow.

—— Le ménage de la ville et des champs, et le jardinier françois . . . avec un traité de la chasse et de la pêche, etc. Bruxelles, 1712. 12°.
Pre-Linn. 1712.1

Chaps. XVII, XVIII, XIX contain "Traité de la pesche."
New ed., enlarged: Paris, 1720.

—— Nouveau théatre d'agriculture ou ménage des champs, et de la ville avec un traité de la chasse et de la pêche. Bruxelles, 1712. 8°.
Pre-Linn. 1712.2

"La pesche," chap. XXXV.
Other eds.: Paris, 1713, 1723, 1732, 1755.

—— Traitté de toute sorte de chasse de pêche. Contenant la manière de faire, racommoder et teindre toutes sortes de filets . . . avec les plus beaux

Liger, *L.*
secrets de la pêche, dans la mer, les rivières et les étangs; et un dictionnaire de tous les termes de filets, de chasse et de pêche, employez dans ce livre. 2 vols. Amsterdam, 1714. xvi, vi, 614 p. 70 pls. 12°. Pre-Linn. 1714.1

—— La nouvelle maison rustique, ou économie générale. 2 vols. Paris, 1721. 4°. Pre-Linn. 1721.1

This compilation superseded "La maison rustique" of Charles Estienne. Under the above or slightly varying titles there are at least 11 editions running as late as 1792.

—— Amusemens de la chasse et de la pêche . . . Avec . . . les plus beaux secrets de la chasse et de la pêche; la manière de faire les rets et les filets, etc. 2 vols. Amsterdam & Leipzig, 1743. 12°. Pre-Linn. 1743.1

This is essentially a version of 1714.1

Liger was the Gervase Markham of his day, and his very popular work, dealing in part with fishing and fish ponds, passed through a large number of editions. Since the title was frequently changed, it has been necessary to indicate the various editions somewhat fully.

Ligon, *Richard* [*fl.* 1650] A true and exact history of the island of Barbadoes. London, 1657. 122 p. pls. fol. Pre-Linn. 1657.1

Fishes, pp. 3–6, 35–36, 39. A French version in a French collection of voyages to Africa and America is:

—— Histoire de l'isle des Barbades. Paris, 1684. 4°. Pre-Linn. 1684.1

Lindblad, *Gust.* (*respond.*) Dissertatio de causis diminutionis piscium. Aboæ, 1757, 9 p. 4°. Pre-Linn. 1757.1

Petr. Kalm, *præses.*

Linden, *Jan Antonid van der* [1609–1664] *Asellus lucius.* (In Selectis Medicis. Amsterdam, 1656, 363. 4°.) Pre-Linn. 1656.1

Linnæus, *Carl von* [1707–1778] For biographies, *see* Hillhouse, W. 1907.1; and Rendle, A. B. 1907.1. For an extensive list of his works and of critical essays on the man and his influence on the development of natural history, *see* Catalogue British Museum (Natural History). London, 1910, vol. III, 1125–1150. *See* also Linnæus, C., in vol. I.

—— Systema naturæ, sive regna tria naturæ systematice proposita per classes ordines, genera, & species, etc. Lugduni Batavorum, 1735. 14 p. gr. fol. Pre-Linn. 1735.1

145 species of fishes enumerated in 36 genera. Other editions of this epoch-making work are:

2nd. Stockholm, 1740. 80 p. 8°.
3rd. Halle, 1740. iv, 70 p. obl. 4°.
4th. Paris, 1744. 108, xxvi p. 8°.
5th. Halle, 1747. 88 p. 8°.
6th. Stockholm, 1748. ii, 224, 27 p. 8 pls. 8°.
7th. Leipzig, 1748. iv, 224, 30 p. 8 pls. 8°.
8th. Stockholm, 1753. iv, 136, 16 p. 3 pls. 8°.
9th. Leyden, 1756. viii, 227, 26 p. 8 pls. 8°.
10th. Stockholm (2 vols.), 1758–59. ii, 1384 p. 8°.

The 10th ed., the international date line in zoology, has been often reprinted, in whole or in part, in various languages. For full title, *see* Linnæus, C. 1758.2.

—— De glutine Lapponico [ex Perca præparando] König. Schwed. Akad. Abhandl., 1739, **1**, 261. Pre-Linn. 1739.1

—— Beschreibung von Gold- und Silberfischen. König. Schwed. Akad. Abhandl., 1740, **2**, 175–184. Pre-Linn. 1740.1

See note under Kästner, A. G. Pre-Linn.

—— Beskrifning om guldfisken och silverfisken. K. Svensk. Vetensk. Akad. Handl., 1740, **2**, 403. — Mélanges Hist. Nat. Dulac, 1740, **1**, 13–25. — Hamburg. Gel. Ber., 1764, 756–761. Pre-Linn. 1740.2

See also Linnæus, C. von. Add. 1762.1

—— Cyprinus pinnæ ani radiis 11, pinnis albescentibus, Staem suecis, descriptus [*Cyprinus grislagine*]. Acta Reg. Soc. Sci., Upsal., 1744–50, 35–36. 3 pls. Notice in Comment. Lips., **1**, 578. Pre-Linn. 1744.1

—— Öländska och Gothländska Resa . . . förrättad åhr 1741. Med anmärkningar uti . . . Natural-Historien, etc. Stockholm & Upsala, 1745. xii, 344, 30 p. ills. Pre-Linn. 1745.1

Various fishes are described.

A German version (Schreber trans.), Halle, 1764 & 1774; Dutch, Dordrecht, 1780. Abridged editions were later issued as "Gothländska Resa," etc. Visby, 1890, and "Öländska Resa," etc. Stockholm, 1907.

—— Fauna Suecica sistens animalia Sueciæ regni: quadrupedia, aves amphibia, pisces, . . . distributa per classes & ordines, genera & species. Cum differentiis specierum, synonymis auctorum, nominibus incolarum, locis habitationum, etc. Stockholmiæ, 1746. 14 leaves. 411 p. 2 pls. 8°. Pre-Linn. 1746.1

Other eds.: Leyden, 1746; Stockholm, 1761; & Leipsic, 1800.

A preliminary list of animals observed by Linnæus in Sweden appeared in "Acta Lit. & Sci. Sueciæ," 1736, **4**, 97–138. It was reprinted in "Oratio de necessitate peregrinatorum intra patriam." Leyden, 1743. Not seen and not known to contain fishes.

—— Wästgöta-Resa . . . Förrättad år 1746. Med anmärkningar uti . . . Naturkunnogheten, etc. Stockholm, 1747. xii, 284, 19 p. 5 pls. 8°. Pre-Linn. 1747.1

Balistes guaperva chinensis figured.
German version by Schreber, Halle, 1765.

—— Amœnitates academicæ, seu dissertationes variæ . . . collectæ et auctæ, etc. Lugduni Batavorum, 1749, vol. I. iv, 610, 9 p. 15 pls. Pre-Linn. 1749.1

In this vol. (I) occur papers (Linnæus, *præses*) by Balk, & Sundius, listed under their names elsewhere.
Dissatisfied with this edition, Linnæus had another prepared, in which the several theses were arranged in chronological order, which appeared as a 2nd ed., Leipsic & Stockholm, 1749. A 3rd ed. appeared, Erlangen, 1787.

—— Skånska Resa . . . Förrättad år 1749. Med rön och anmärkningar uti . . . naturalier, etc. Stockholm, 1751. xiv, 434 p. 6 pls. 8°. Pre-Linn. 1751.1

Cyprinus cultratus & *Gadus merlangus* figured.
An abridged German ed. is:

Versuche einer Natur-Kunst- und Oeconomie-Historie von einigen Schwedischen Provinzen, übersetzt von C. E. Klein. Stockholm & Leipzig, 1756. 8°.

—— Pisces (In his Museum S. R. M. Adolphi Friderici Regis Suecorum . . . in quo animalia rariora imprimis et exotica . . . describuntur et determinantur, Latine et Suecice, etc. Holmiæ, 1754. 133 p. 32 pls. fol.) Pre-Linn. 1754.1

89 fishes are figured and described. Contains earliest known figure and description of catfish egg and embryo (*Ascita ventricosa*), p. 79.
Copies, A. M. N. H., & P. I.
A previous catalogue of these specimens by L. Balk appeared as a thesis, Holmiæ, 1746, 48 p. 2 pls.; and in Amœnitates Academicæ, 1749, **1**, 556–610. (*See* Balk, L., 1749.1).
For later works of Linnæus, *see* in Vol. II.

Linocier, *Geoff.* [*c.* 1550–*c.* 1620] L'histoire des plantes, traduicte de Latin [of Du Pinet] en Françoise . . . à laquelle sont adioustées celles des simples aromatiques, animaux à quatre pieds, oiseaux, poissons, serpens, & autres bestes venimeuses (receuilles de Gesnerus & autres bon approuvez autheurs) . . . etc. Paris, 1584. 593 p. 12°. Pre-Linn. 1584.1

Other eds.: 1619–20 (2nd), 8°; & 1622. 16°, with woodcuts.

Linschoten, *Jan Huygen van* [1563–1611] Itinerario, voyage ofte schipvaert van J. H. van Linschoten naer oost ofte Portugaels Indien, inhoudende een corte beschryvinge der selver landen ende zee-custen. Amstelredam, 1595–96. viii, 160 leaves. pls. maps. fol. Pre-Linn. 1595.1

Remora as a ship-holder. Indian fishes described.
This seems to be the *editio princeps.* Other eds. are: Amsterdam, 1605, 1614, 1623 and 1644; 1660–70. Various versions follow:

—— J. Huighen van Linschoten, His discours of voyages into ye Easte and West Indies, in foure bookes. London, 1598. 462 p. fol. Pre-Linn. 1598.1

Book I, chap. XLVIII, Remora as a ship-stopper. Fishes in the seas of India.
Most available for present-day English readers as: "The voyage of J. Huyghen van Lindschoten to the East Indies . . . edited (with introduction) by . . . P. A. Tiele. Hakluyt Society, Works, no. 71, 1885."

—— Navigatio ac itinerarium J. H. Linscotani in Orientalem sive Lusitanorum Indiam. Descriptiones ejusdem terræ . . . etc. The Hague & Leyden, 1599. fol. Pre-Linn. 1599.1

—— Histoire de la navigation de Jean Hugues de Linscot Hollendois et de son voyage en Indies Orientales, etc. Amstelredam, 1610. ii, 275 leaves. fol. Pre-Linn. 1610.1

Two other French eds. at Amsterdam, 1619.
Various editions of Linschoten's works in N. Y. P. For collations of these and other works by Linschoten, *see* Thiele, P. A. Nederl. Bibliog. Land-en-Volken Kunde. Amsterdam, 1884.
For a modern Dutch version of the above work by Linschoten, together with a bibliography of his writings, *see* the 2 vol. edition issued by the Linschoten-Vereeniging at The Hague in 1910, under the editorship of Dr. H. Kern.

Lipenius, *M. Mart.* Dissertatio Ionæ diaplus Thalasius, in qua de pisce Ionæ portatore. Wittebergæ, 1678. 4°. Pre-Linn. 1678.1

Lipstorp, *D. Dan.* (*præses*) Dissertatio de iure venationis et aucupii. Upsaliæ, 1663. 4°. Pre-Linn. 1663.1

Jo. G. Salenius, *respond.*

Lister, *Martin* [*c.* 1638–1712] Observations and experiments made for the Royal Society. Phil. Trans. Roy. Soc., 1674, **9**, 221–226. Pre-Linn. 1674.1

Tricuspid shark's teeth lacking serrations, p. 223.

—— Pisces [in] Appendix ad historiam naturalem piscium. (In Willughby, F. De historia piscium, etc. Oxonii, 1686. fol. ills.) p. 19–27. Pre-Linn. 1686.1

Lloyd, *Edward. See* **Luid,** *Edward.*

Lochner von Hummelstein, *Johann Heinrich* [1662–1720] Rariora musei Besleriani, quæ olim Basilius et Michael Rupertus Besleri collegerunt, æenisque tabulis ad vivum incisis evulgerunt, nunc commentariolo illustrata a Johanne Henrico Lochnero, . . . denuo luci publicæ commisit Michael Fridericus Lochner. Norimbergæ, 1716. xxiv, 112 p. 41 pls. Pre-Linn. 1716.1

Seven fishes figured and described, p. 55–68. Fossil fishes, p. 93–94. Glossopetras, p. 105. Copy, A. M. N. H.

The contents of the Museum were collected and were figured on copper by B. and M. R. Besler and the descriptive text written by J. H. Lochner von Hummelstein. *See* also Besler, B. & M. R.

L[ocke], *J.* An extract of a letter written to the publisher by Mr. J. L. about poisonous fish in one of the Bahama islands. Phil. Trans. Roy. Soc., 1675, **10**, 312. Pre-Linn. 1675.1

Poisoning from eating Barracuda.

L[odewijcksz], *G. M. A. W.* D'eerste boeck. Historie van Indien, waer inne verhaelt is de avontueren die de Hollandsche schepen bejeghent, etc. Amstelredam, 1598. obl. 4°. Pre-Linn. 1598.1

Fishes, chap. XIV with pl. Methods of fishing at Gammelaume.

Other & identical eds.: 1609, 1617. French & Latin versions follow:

—— Premier livre de l'histoire de la navigation aux Indies Orientales par les Hollandois, etc. Amstelredam, 1598. 54 pls. fol. Pre-Linn. 1598.2

Chap. XIV, flying fishes, sharks, remoras, albicores, etc., described. Plate showing fishes, p. 16.

Another ed., Amsterdam, 1601.

—— Prima pars descriptiones itineris navalis Indiam orientalem, etc. Amstelredami, 1598. fol. Pre-Linn. 1598.3

Chap. XIV, flying and other fishes. fig.

Another ed., Amsterdam, 1614. Copies of all the above, N. Y. P.

The same data is contained also in Neck, J. C. 1598.1, this section.

Löwe, —— *von.* Von den Räubern der Karpfenbrut. Samml. Nat. u. Med. Kunst. u. Litt.-Gesch. Breslau, 1718, 4. Vers., 1222. Pre-Linn. 1718.1

Lonicer *or* **Lonitzer,** *Adam* [1528–1586] For a sketch of his life, *see* Roth, F. W. E., in Centralb. für Bibliothekswesen, 1902, 19. Jahrg., 277–281.

—— Naturalis historiæ opus novum, in quo tractatur de natura et viribus arborum, fruticum, herbarum, animantiumque terrestrium, volatilium et aquatilium, etc. 2 vols. Francofurti, 1551–55. 706 p. 50 pls. fol. Pre-Linn. 1551.1

"A work more remarkable for its longevity than its quality." — Miall.

Much of Lonicer's material came from J. von Cube.

The 2nd vol. apparently contains plants only.

—— Kräuterbuch näbst Beschreibung der fürnehmsten Thiere, . . . Fischen, . . . &c. Francofurti, 1546. fol. Pre-Linn. 1546.1

This work, apparently a German translation of the preceding, passed through many eds.: Nuremberg, 1628, & 1678; Augsburg, 1713; Ulm, 5 eds., 1570–1770; & at Frankfort, 13 eds. between 1546 & 1650. The last ed., Ulm [or Augsburg], 1783. fol.

Lonicer, *Johann Adam.* Venatus et aucupium, iconibus ad vivum expressa, et succinctis versibus illustrata. Francofurti, 1582. 4°. Pre-Linn. 1582.1

With 40 plates, by Jost Amman, of hunting, hawking, fishing, fowling, etc.

Lonitzer, *Adam.* *See* **Lonicer,** *Adam.*

Lorenzini, *Stefano.* For a historical note on Lorenzini and on our knowledge of the Torpedo, *see* Boll, Franz. 1874.1.

—— Osservazioni intorno alle torpedini. Firenze, 1678. 136 p. 4°. figs. Pre-Linn. 1678.1

—— De anatomia torpedinis. Ephemer. Acad. Nat. Cur., 1678–79 (1693), 2. dec., ann. 9 & 10, 389–395. Pre-Linn. 1693.1

—— De linguis piscium. Ephemer. Acad. Nat. Cur., 1678–79 (1693), 1. dec., ann. 9 & 10, 406–408. Pre-Linn. 1693.2

—— De vi stupefactiva torpedinis ex ejusdem osservazioni intorno alle torpedini excerptum. Misc. Acad. Nat. Cur., 1678–1679 (1693), dec. 1, ann. 9 & 10, 395–406. Pre-Linn. 1693.3

—— The curious and accurate observations on the dissections of the cramp-fish, done into English by J. Davis. London, 1705. 75 p. 5 pls. 4°. Pre-Linn. 1705.1

—— Descriptio anatomica torpedinis. (In Valentini, M. B. Amphitheatrum Zootomicum, Francofurti, 1720, pt. II, 110–115. pl.) Pre-Linn. 1720.1

A post-Linnæan version is:

Beschreibung und Zergliederung der Krampfroschen. (In Schneider, J. G. Sammlung von anatomischen Aufsätzen und Bemerkungen zur Aufklärung der Fischkunde. Leipzig, 1795. Th. 1.)

Lovell, *Robert* [1630–1690] Panzoologicomineralogia. Or a compleat history of animals and minerals, containing the summe of all authors, both ancient and modern . . . Oxford, 1661. xcvi, 519, 152 p. 8°. Pre-Linn. 1661.1

Fishes named, structure and action given, in introduction. Fishes of England and their uses, in introduction. Ichthyologia. p. 185–232. Fishes used as food or medicine, p. 232–241.
Copy, Col.

Low, *Johannes.* Eine art, die Fischottern lebendig zu fangen, und sie abzurichten dass sie Fische bringen. König. Schwed. Akad. Abhandl., 1752, **13**, 147. Pre-Linn. 1752.1

See note under Kästner, A. G. *See* also Low, J., Add. 1762.1.

—— Sätt at fänga uttrar lefvande och inrätta dem, at bära hem fisk. K. Svensk. Vetensk. Acad. Handl., 1752, **13**, 139–149. Pre-Linn. 1752.2

—— Konst om de otters levendig te vangen tam te maaken, en zo af te rigten dat zy visch aanbrengen. Uitgez. Verh. 1757, **2**, 61–69. Pre-Linn. 1757.1

Ludolf, *Hiob* [1624–1704] Historia Aethiopica, sive descriptio regni Habessinorum, etc. Frankfort, 1681. fol. Pre-Linn. 1681.1

Book II, chap. XI, contains a reference to a fish called "Torpedo," presumably Malopterurus. If correctly identified, this is probably the earliest known reference to this fish.
Versions in other languages are:

—— A new history of Ethiopia. Being a description of the kingdom of Abessinia . . . wherein are contained . . .; their birds, beasts, amphibious animals . . . serpents, etc. London, 1682. viii, 398 p. 9 pls. 4°. Pre-Linn. 1682.1

—— Nouvelle histoire d'Abissinie ou d'Ethiopii. Paris, 1684. figs. 8°. Pre-Linn. 1684.1

—— Nieuwe doch aanmerkenswaardige historie van Abissinien andersints Ethiopien, etc. Utrecht, 1687. 220 leaves. 4°. Pre-Linn. 1687.1

Luid, Luyd, Lhuyd, *or* **Lloyd,** *Edward* [*c.* 1660–1709] Epistola; in qua agit de lapidibus aliquot perpetua figurâ donatis, quos nupires annis in Oxoniense & vicinis agris adinvenit. Phil. Trans. Roy. Soc., 1693, **17**, 746–754. Pre-Linn. 1693.1

Bufonites, ichthyospondylas, and glossopetras (fossil sharks' teeth), p. 749–754.

—— Lithophylacii Britannici ichnographis, sive lapidum aliorumque fossilium Britannicorum singulari figura insignium; etc. Londini, 1699. 23 pls. 8°. Pre-Linn. 1699.1

Fossil sharks' teeth and fishes' jaws.
2nd. ed., 1760.

Lund, *Carl Frid.* Neue Art, einen Canal oder Fischteich mit verschiedener Gattung Fische anzufüllen. Brem. Magaz., 1757, **1**, 2. St., no. 61. Pre-Linn. 1757.1

Luyd, *Edward. See* **Luid,** *Edward.*

M

Maffei, *Scipio* [1675–1755] For a sketch of his life and a collection of his letters, *see* Pindemonte, V. "Elogi di Letterati." Verona, 1825–26, vol. I.

—— Della formazione de' fulmini. Trattato raccolto da varie sue lettere; in alcune delle quali si tratta anche degli insetti rigenerantisi, e de' pesci de mare su i monti, e più a lungo dell' elettricità. Verona, 1747. pls. 4°.
Pre-Linn. 1747.1

"Come siano andate su le montagne i marini testacei, e i pesci di mare, che impietriti si scoprono ne' macigni. Lettera al Sig. De La Condamine." — Dal Nero.

—— Brief von versteinerten Muscheln und Fischen, die in den Bergen gefunden werden. Nord. Beitr., 1757, **1,** 1–22. Pre-Linn. 1757.1

—— Gedanken von Blitz, Insekten und verschiedenen Seefischen auf den Bergen. Leipsic, 1758. 8°.
Pre-Linn. 1758.1

German version of "Della formazione."
For works of Maffei published after 1758, *see* Maffei, S., 1795.1.

Magalhanes de Gandavo, *Pedro de* [1540–] Histoire de la province de Santa Cruz, que nommons ordinairement le Brésil. Lisbon, 1576.
Pre-Linn. 1576.1

Fishes, chap. 8.
Available today in Ternaux, Henri. "Voyages, relations et mémoires originaux pour servir à l'histoire de la découverte de l'Amérique, publiés pour la première fois en français." Paris, 1837, p. 91–99.

Magnus, *Olaus* [*c.* 1490–1568] Historia de gentibus septentrionalibus earumque diversis statibus, conditionibus, moribus, ritibus, superstitionibus. Romæ, 1555. figs. 4°.
Pre-Linn. 1555.1

Lib. xx. De piscibus et de piscatione; de Halece sive arenga; Lib. xxi. De piscibus monstrosis: p. 697–778.
1st ed. Others: (full text) Venice, 1565 (Italian); London, 1658 (English); Amsterdam, 1599 & 1665 (Dutch), 1652, 1699 (Latin); Strassburg, 1667 (German): (abridged form) Antwerp, 1558 & 1562; Paris, 1561 (French); Basel, 1567; Amsterdam, 1586; Frankfort, 1618; Leiden, 1652 (Latin). Three of these eds. are:

—— Historia delle genti et della natura delle cose settentrionali. Venice, 1565. Pre-Linn. 1565.1

—— De wonderlycke historie der noordersche landen, beschreven door Olaus de Groote. Ook after aen by ghevoecht verscheyden waerchtige navigatien tegent noorden ghedaen by onsen tyt, als op Nova-Zembla, Groenland en door de Strate van Nassouwen anders Weygats ghenaemt. Amsterdam, 1599. 4°. Pre-Linn. 1599.1

Fishes, books 21 & 22.

—— A compendious history of the Goths, Swedes and Vandals and other northern powers. Translated by J. S. Powers. London, 1658. fol.
Pre-Linn. 1658.1

"Whatever Olaus Magnus, titular Archbishop of Upsala, may have been as a describer of national customs and a collector of folklore, he sinks to the mediæval level in his descriptions of animals." — L. C. Miall.

Major, *D. B.* Unvorgreiffliches Bedencken von Kunst- und Naturalien-Kammern insgemein. (In Valentini, M. B., Museum Museorum, oder vollständige Schau-Bühne aller Materialien und Specereyen, . . . etc. Franckfurt-am-Mäyn, 1704. 76 p. fol.)
Pre-Linn. 1704.1

Fossil shark's teeth figured and described, p. 58.
2nd ed., 3 pts.: Frankfort, 1714.

Major, *Johannes Henry.* Brevis & accuratæ historiæ animalium in sacro cumprimis codice commentatorium libri ii. Francofurti & Spiræ, 1685. 8°.
Pre-Linn. 1685.1

Jonah and the shark.
See also Pfeiffer, S. A. in this section.

Malm, *Nicolas* (*respond.*) Ichthyotheologiæ primæ lineæ. Inaug. Dissert. Aboæ, 1751. 37 p. 4°.
Pre-Linn. 1751.1

Carl Fred. Menander, *præses.*

Malpighi, *Marcello* [1628–1694] For sketches of his life and work, *see* Locy, W. A. 1908.1 (p. 58–67); & Pop. Sci. Mo., 1901: also Miall, L. C. 1912.1 (p. 145–166).

—— Opera omnia. 2 vols. Londini, 1686. fol. Pre-Linn. 1686.1

The above are often found collected in one or two volumes. They were reprinted without editing and the pagination is not continuous, so that reference is troublesome. In one of the author's contributions, the optic nerve of the swordfish is described.

Another ed., Leyden, 1687 (2 vols. in 1). Posthumous eds.: London, 1697, & Amsterdam, 1698.

Manardi, *Giovanni* [1462–1536] De Silurus antiquorum dissertatio. Ferrara, [c. 1560] Pre-Linn. 1560.1

"Cited by Conrad Gesner, in his 'Fischbuch,' as having identified the Glanis of ancient writers with the Danube catfish known in modern nomenclature as *Parasilurus glanis*. The form is illustrated by Gesner, and also, according to Killermann, in the manuscript work of Petrus Candidus, written in 1460." — C. R. Eastman.

Mandelslo, *Johann Albrecht* [1616–1644] Beschryving van den gedenkwaerdige zee- en land-reyze deur Persien naar Oost-Indien, etc. Amsterdam, 1658. viii, 150 leaves. 4°. Pre-Linn. 1658.1

This celebrated work, first published at Schleswig in 1645, passed through a number of editions. Some are (German) Schleswig, 1645, 1647, 1658; (Dutch) Amsterdam, 1651 & 1659; (English) London, 1696; (French) Leyden, 1719 & 1727. It was also reprinted in Arkstee & Merkus, Allg. Hist. Reisen, etc. 1753, XI, under the title "Reise nach Indostan."

—— The voyages and travels of J. A. de Mandelslo . . . into the East Indies (In Olearus, Adam. The voyages and travels of the Ambassadors sent . . . to the great duke of Muscovy, and the king of Persia, etc. London, 1662. 4°.) Pre-Linn. 1662.1

—— Morgenländische Reise-beschreibung, herausgegeben durch A. Olearium mit desselben Anmerkungen. Hamburg, 1696. 174 p. fol. Pre-Linn. 1696.1

—— Voyages célèbres et remarquables faits de Perse aux Indes Orientales; contenant une description nouvelle et très curieuse de l'Indostan, de l'Empire du Grand-Mogol, des îles et presqu'îles de l'Orient, des royaumes de Siam, du Japon, du Congo, de la Chine, etc. 2 vols. [in 1] Leide, 1713. pls. maps. fol. Pre-Linn. 1713.1

Fishes, p. 88, 209, 280, 464, 559, 573, 619, 620–621, 623, 627, 634, 670, 673, 675, 684.

Mandeville, [*Bernard.* 1670–1733] Zoologia medicinalis hibernica, or A treatise of birds, beasts, fishes, reptiles and insects, giving an account of their medicinal virtues. Dublin, 1739. 8°. Pre-Linn. 1739.1

Another ed.: London, 1744.

Mandeville, (*Sir*) *John* (*pseudon.*) [c. 1350] For bio- and bibliographical data about the compiler who wrote under this name and about his book of travels, *see* article in Encyclopædia Britannica (11th ed.) 1911, vol. XVII, by E. W. B. Nicholson & Henry Yule; also A. Bovenschen's "Untersuchungen über Johann von Mandeville und die Quellen seiner Reisebeschreibung" in Zeitschr. Ges. Erdkunde, Berlin, 1888, Bd. XXIII, Heft. 3 & 4.

Other authoritative articles are that by G. F. Warner in the Dictionary of National Biography; and John Ashton's introduction to the modern ed. listed below. Ashton also gives lists of MS. and printed editions.

—— Ce livre est appele mandeville et fut fait et compose par monsier jehan de mandeville chevalier natif dangleterre de la ville de sainct alein, etc. 1480. fol. Pre-Linn. 1480.1

Thought to be the earliest dated copy.

—— Itinerario. Explicit Johannes de Mandeville militis. Mediolani, 1480. 4°. Pre-Linn. 1480.2

—— Itinerarius Domini Johannis de Mandeville militis. [n. p., n. d. (c. 1480)]. Pre-Linn. 1480.3

These are believed to be the first eds. in Italian and Latin. Ashton lists 21 eds. ante 1500; 17 in the 16th, and 10 in the 17th centuries, 12 from 1700–1742, and 17 from 1760–1881. The oldest English version seems to be:

—— The boke of John Maunduyle Knyght of wayes to Jerusalem and of marvels of ynde and of other countries. [n. p., n. d.]

Printed by Pynson between 1493 & 1499.

A modern English reprint of this is:

The voiage and travayle of Sir John Maundeville Knight, etc. London, 1887. 289 p. ills. 12°.

Edited by John Ashton with facsimile reproductions of many old figures. For the latest English version known to us, *see* Mandeville, Sir J. 1915.1.

Mandeville gives brief accounts of fish and fishing in the various countries visited — earliest account of fishing with the otter, among others (chap. LIII).

Mangolt, *Gregory* [1497–] Fischbuch von der Natur und Eigenschafft der Vischen, insonderheit deren so gefangen werdend im Bodensee und in andern Seen und Wasseren. Item wie man Fisch und Vögel fahen sölle. Zürich, 1520. 70 p. 12 pls. Pre-Linn. 1520.1

There are also editions of "Fischbuchs" of 1557, 1576, 1578, & 1598, all at Zurich and all credited to Mangolt. The last is probably the best edition. The full title is:

Mangolt, *G.*

—— Fischbuch von der Natur und Eigenschaft der Fischen, insonderheit deren so gefangen werden im Bodensee, und gemeinlich auch in anderen Seen und Wassern, durch den wohlgeleerten Gregorium Mangolt beschrieben, vormals nie gesähen. Item ein ander Büchlin wie man Fisch und Vögel fahen sölle, mit dreyssig neuen und bewärten Recepten. Auch zu was Zeyten im gantzen Jar ein yeder Fisch am besten seye. Zürich, 1598. figs. Pre-Linn. 1598.1

Maplet, *John* [–1592] A greene forest, or a natural historie, wherein may bee seene the most sufferaigne vertues in all the whole kinde of stones and mettals; of brute beastes, fowles, fishes, &c. London, 1567. 112 leaves. 12°. (*black letter.*) Pre-Linn. 1567.1

Maraldi, *Jas. Phil.* [1665–1729] [Remarks on fossil fishes from Mt. Lebanon, Syria, Sicily and Monte Bolca, Italy.] Mém. Acad. Sci. Paris, 1703 (1720), hist., 22–24. Pre-Linn. 1720.1

Marcellus *Sidetes* (*fl.* 135) Iatrica de piscibus, græce et latine, per Fed. Morellum sub tit.: De remediis ex piscibus. Paris, 1591. 4°. Pre-Linn. 1591.1

—— [Fragmentum de piscibus] (With Oppian's "Poemata de venatione et piscatione," etc. Argentorati [Strasburg], 1680). Pre-Linn. 1680.1

—— [Medicina ex piscibus] (In Jo. Alberti Fabricii Bibliotheca Græca, sive notitia scriptorum veterum Græcorum, etc. Accessit . . . Marcelli Sidetæ carmen de medicamentis è piscibus, Græce & Latine, cum brevibus notis. Hamburgi, 1705.) Pre-Linn. 1705.1

Medicine from fishes, p. 14–20. Latin and Greek on opposite pages, 101 lines. About 75 fishes are named and 2 are specified as follows: "De usu mulli in iis qui carbunculo laborant," "De pastinaca & aliis remediis adversus læsionem serpentis marini, aliaque."

An earlier ed., Hamburg, 1704; a later:

—— De medicina ex piscibus, fragmentum poëmatis interprete Fed. Morello, Paris. Professore Regio. (In Jo. Alberti Fabricii Bibliothecæ Græcæ. Hamburgi, 1726, vol. XIII, 317–320.) Pre-Linn. 1726.1

Bio- and biblio-graphical data on Sidetes, p. 315–316.

Also found in modern form in Kühn, C. G. (præses):

Collectanea de Marcello Sideta I–V. Leipsic, 1834–35. 60 p. 4°.

Copy of this collection of 5 theses by students of Kühn in Surg. Gen. Lib.

Marcgrave, *George* [1610–1644] His name is also spelled Markgrave, Marggrave, Margrave, Markgraf, Marggraf, Marcgraf, etc. For an account of the life and work of Marcgrave, and for a full bibliography of Marcgrave material, *see* Gudger, E. W. "George Marcgrave, the first student of American natural history," Pop. Sci. Monthly, 1912, **73,** 250–274; — Zool. Annalen (W. Breitenbach, trans.), 1914, **6,** 1–31; also "George Marcgrave, a postscript" Science, 1914, n. s. **40,** 507, by the same author: and Zaunick, Rudolph. "Nachtrag zu Gudger's Arbeit über Georg Marcgrave," Zool. Annalen, 1919, **7,** 193–195.

——Brasilianische Naturgegenstände, (Collectio rerum naturalium Brasiliæ) [*c.* 1643] Pre-Linn. 1643.1

These water-color drawings of the animals and plants of Brazil, made by Marcgrave, are preserved in the great library of Berlin, labelled "Libri Picturati A. 36–37." There is reason to believe that Count Maurice of Nassau-Siegen made some of these paintings. On at least some of the figures of fishes there are notes in his handwriting. They are (in part) the originals of the figures in Marcgrave's great work.

—— Historiæ rerum naturalium Brasiliæ libri VIII., a Joh. de Laet in ordinem digesti et annotationibus illustrati. Lugduni Batavorum et Amstelodami, 1648. figs. fol. Pre-Linn. 1648.1

This work, written in Brazil in cipher, was translated and edited by Jan de Laet. It forms section two of the "Historia Naturalis Brasiliæ," Leyden and Amsterdam, 1648, fol.

The first section of this volume is composed of William Piso's "De Medicina Brasiliensi," comprising four books.

The second section, by Marcgrave, comprises 303 folio pages, consisting of eight books and an appendix, and is illustrated by 429 figures. Book IV treats of fishes and crustaceans, both freshwater and marine, 105 of the former being described and 86 figured. Most of the figures were drawn by the author himself, as stated at the foot of the table of contents.

For elaborate commentaries on this work, *see* Lichtenstein, H., 1818.1, and Gudger, E. W., in the paper cited above.

—— G. Marcgravii Historiæ rerum naturalium Brasiliæ (In Piso, G. "De Indiæ utriusque re naturali et medica libri quatuordecim." Amsterdam, 1658. fol.) Pre-Linn. 1658.1

Feeling aggrieved over De Laet's editing of the "Historia Naturalis Brasiliæ," Piso ten years later rewrote the whole book under the above title and completely appropriated all Marcgrave's work and material. For all the data bearing on this matter, *see* Gudger's sketch of Marcgrave, above.

Marcucius, *Casp.* Dissertatio de jejunio et esu piscium in vere, adversus Leonh. Fuchsium. Venetiis, 1624. 12°. Pre-Linn. 1624.1

Title from Boehmer. Not found elsewhere.

Marées, *Pieter de.* Beschryvinge ende historische verhael van 't gout koninckrijck van Guinea, anders de Gout-custe de Mina genaemt, . . . etc. Amsterdam, 1602. viii, 129 p. obl. 4°. Pre-Linn. 1602.1

The 1st ed. Other Dutch eds.: Amsterdam, 1617 & 1650.

It also appeared in De Bry, "India Orientalis," Pt. vi; German, 1603, as "Warhaftige . . . Beschreibung dess gewaltigen goltreichen Königsreich Guinea." Also in "Purchas his Pilgrims," first in Latin and later in English.

—— Description et récit historical du riche royaume d'or de Gunea, etc. Amsterdamme, 1605. fol. Pre-Linn. 1605.1

Fishing by day and by night, pl. 9 (double). Chap. xxix deals with fishing and the fishes taken. Fishes, chap. xxxiii, p. 63–64.

—— Beschryvinge van de goudtkust Guinea; alsmede een voyage naer deselve. Waerin den aert des landts Koopmanschap, gedierten, vogelen, visschen . . . en visscherije der Swarten . . . seer duydelijck beschreven worden. Amsterdam, 1650. 5 pls. 4°. Pre-Linn. 1650.1

Fishes, p. 89–92. Fishing by day and by night, 2 pls. and description.
Copies 1605 & 1650 eds., N. Y. P.

Mareschalcus, *Nicol* [1460–1525] Thurii historia aquatilium. Rostoch, 1517. fol. Pre-Linn. 1517.1

This work, written in both Latin and Greek, describes the fishes of Thuringia.
A later and better known edition is:

—— Historiæ aquatilium lib. i. et ii, latine et græce. Rostochii, in ædib. Thuriis, 1520. figs. fol. Pre-Linn. 1520.1

An exceedingly rare work, mentioned by J. V. Carus in his "Geschichte der Zoologie," p. 269, and by Beckmann in his "Geschichte der Erfindungen," Bd. III, p. 431.

Margarita Philosophica. *See* **Reisch,** *Gregory (editor).*

Marggrave; Margrave, *or* **Markgraf,** *George. See* **Marcgrave,** *George.*

Markham, *Gervase* [*c.* 1568–1637] The young sportsman's instructor in angling, fowling, hawking, hunting, etc. [*c.* 1597] Pre-Linn. 1597.1

Another (dated) ed.: London, 1652. Republished, London, 1820; & in "The angler's garland and fisher's delight," 1871.

—— The second book of the English husbandman . . . contayning a discourse of the general art of fishing with the angle, etc. London, 1614. xiv, 205 p. 4°. Pre-Linn. 1614.1

The first half of the "English husbandman," published 1613 and again 1614 & 1635, contains nothing on fishing. Other eds. "Second book": 1615 & 1635.

—— The pleasures of princes, or good mens recreations. Contayning a discourse of the generall art of fishing, with the angle, or otherwise, and of all the hidden secrets belonging thereunto; . . . London, 1614. 54 p. sm. 4°. Pre-Linn. 1614.2

This forms the second part of the second book of his "English husbandman." The "art of fishing" was also used by Markham in his "Country contentments"; it contains many extracts rendered into prose, from the "Secrets of angling" by John Dennys. It was subsequently reprinted in 1615 and in 1635. It in turn was followed by:

—— Cheap and good husbandry . . . together with . . . the making of fish ponds, and the taking of all sorts of fish. London, 1616. xx, 182 p. 4°. Pre-Linn. 1616.1

"Of fishing," chaps. i & ii. Other eds. followed, at least 16 appearing before 1683.

The "Way to get wealth." London, 1638, and many later editions apparently do not have anything on fishing. This appears, however, in:

—— Countrey contentments; or the husbandman's recreations . . . The whole art of angling, etc. London, 1631. x, 117 p. 4°. Pre-Linn. 1631.1

4th ed. Earlier eds. (1611, 1613, 1615) do not contain "The whole art of angling," which is found in this and the 7 eds., 1635–1657.
An outgrowth of the above works is:

—— A compleat and experienced angler . . . or the angler's vade mecum, etc. London, [*c.* 1712]. iv, 138 p. 24°. Pre-Linn. 1712.1

This was followed by a number of other works, and by editions of the various preceding books, all of which seem to contain chapters on angling and on the care of fish.

For lists of Markham's books with notes on their contents, *see* Lowndes, and Westwood & Satchell. For a commentary on "The art of angling," etc. 1614, *see* Marston, R. B. 1894.1.

Markham was the pioneer English hack writer. He borrowed right and left, wrote with ease, and printed his books in many confused editions. His first purloining was a reprint of the "Book of St. Albans" in 1595 under the title "The gentleman's acadamie, or the boke of St. Albans, etc. reduced to better form by G. M." He is one of the "old farmers" discussed by Donald G. Mitchell in his "Wet days at Edgewood" (1865.1).

Marshe, *Thomas.* A briefe collection and compendious extract out of the cosmography of Seb. Munster; wherein is made . . . a true report of the nature and properties of certaine fowles, fishes, monsters, etc. London, 1574. 8°. Pre-Linn. 1574.1

Marsigli, *or* **Marsili,** *or* **Marsilli,** *Luigi Ferdinando* (*Comte de*) [*c.* 1656–1730] Elogy in Bibl. Franç., **17,** 2. pt., no. 3. — Leipzig. Gel. Zeit., 1733, 907. Life by Angelo Fabroni in Archiv Neusten Geschichte. 1. Th., 5. *See* also Quincy, L. D. C. H. D. "Mémoires sur la vie de M. le Comte de Marsigli." 4 vols. Zurich, 1741. sm. 8°; and Fantuzzi's biography, Bologna, 1770.

—— Brieve ristrétto del saggio fisico intorno alla storia del mare. Venice, 1711. 72 p. figs. gr. 4°. Pre-Linn. 1711.1

—— Lettera scritta al Sig. Ant. Vallisnieri intorno all' origine della anguilla. Giorn. Letter. Ital., 1717, **29,** 206. Pre-Linn. 1717.1

Republished in Acta Vratisl. **5**, p. 1690. A French version of the first title is:

—— Histoire physique de la mer. Ouvrage enrichi de figures dessinées d'après le naturel. Amsterdam, 1725. fol. 173 p. 41 pls. Pre-Linn. 1725.1

Translated into Dutch as "Natuurkundige Beschryving der Zeen," etc. The Hague, 1786. xxv, 216 p. 50 pls. fol.

—— Danubius Pannonico-Mysicus, observationibus historicis, physicis perlustratus et in sex tomos digestus. 6 vols. [in 3]. Hagæ Comitum & Amstelodami, 1726. illust. fol. Pre-Linn. 1726.1

Tom. IV. De piscibus in aquis Danubiis viventibus. Tom. VI. Observationes anatomicæ in Husone.

Reviewed in Acta Erud. Lips., 1727; and in Comm. Litt. Norimb., 1763. A French translation is listed below (1744).

—— Lettera ad Antonio Vallisnieri il quale portatosi a bella posta sul Monte Bolca, ne da una descrizione del luogo dove i pesci di mare si trovano, etc. (In Vallisnieri, A. De' corpi marini che sui monti si trovano. Venezia, 1728, 141–150.) Pre-Linn. 1728.1

—— Lettera ad Antonio Vallisnieri di Luigi Ferdinando Marsilli . . . il quale portatosi a bella posta sul monte Bolca, ne dà non solamente una perfettissima descrizione, ma espone la fotografia del luogo dove i pesci di mare e molti crostacei si trovano . . . Con una notizia di A. Vallisnieri di un pesce di mare pieno d'uova trovato nel monte Bolca. (In Opere fisico-mediche stampate e manoscritte del kavalier Antonio Vallisnieri raccolte da Antonio suo figlio. Venezia, 1733, p. 359–363.) Pre-Linn. 1733.1

—— Description du Danube, depuis la montagne de Kalenberg jusqu'au confluent de la rivière Jautra, contenant des observations géographiques, hydrographiques, historiques et physiques. La Haye, 1744. 6 vols. fol. Pre-Linn. 1744.1

Les poissons du Danube. Vol. IV, 33 pls.

Martens, *Friedrich* [1635–1699] Spitzbergische oder Grönländische Reisebeschreibung, gethan im Jahre 1671. Hamburg, 1675, 132 p. 16 pls. 4°. Pre-Linn. 1675.1

Various versions follow.

—— Viaggio di Spizberga o Gronlanda fatto da Federico Martens Amburghese l'anno 1671 . . . con una copiosa relazione di quell' aggiacciato clima, e de gli uccelli, quadrupedi, pesci, e piante rare, che vi nas-cono, colla descrizione delle Balene, e lor pesca . . . Bologna, 1680. 264 p. ills. 12°. Pre-Linn. 1680.1

—— Voyage into Spitzbergen and Greenland. (In "An account of several late voyages to the south and north. London, 1694) 207 p. pls. Pre-Linn. 1694.1

Fishes, chap. VI, p. 120–129.
Full English version; an abbreviated is:

—— [A voyage to Spitzbergen, in the ship call'd the "Jonas in the Whale," Peter Peterson of Frieseland, Master, in 1671.] (In Harris's Coll. Voy. and Trav. 1705, vol. I, 617–633.) Pre-Linn. 1705.1

Of the finned fishes, p. 628.

There are Dutch translations at Amsterdam, 1685, and 1710, and there are various abridgments in various collections of voyages from 1694 to 1768. The work is best available to the present day English reader in White's edition in Hakluyt Soc., Works, no. 18. 1855.

Martin, *Martin* [–1719] A description of the western islands of Scotland, containing a full account of their situation, extent, soils, product, harbours, bays, tides, anchoring places and fisheries. London, 1716. 8°. Pre-Linn. 1716.1

The 2nd and augmented ed., the 1st having been issued in 1703. At Glasgow in 1884, a page for page reprint of the 2nd ed. was issued.

This work abounds in references to fish and fishing, which may readily be located by means of its detailed table of contents.

Martyn, *Benjamin* [1699–1763] Grammatica philosophica, conspectus statûs præsentis physiologiæ naturalis sistens, quatuor partibus. Pars IV. de globo terraqueo, etc; etiam partes cor-

porum animalium et naturam bestiarum, piscium, insectorum, reptilium per dialogos exposita. London, 1735. fig. 8°.
Pre-Linn. 1735.1

Martyr, *Peter* (*d'Anghera*) [1457–1526] For a sketch of his life and work and a bibliography of his publications, together with a list of books relating to his writings, *see* Schumacher, Hermann A. "Petrus Martyr der Geschichtschreiber des Weltmeeres. Eine Studie" [with copious notes] New York, 1879. 152 p. Also McNutt, F. A., translator and editor, cited in footnote below.

—— Libretto di tutta la navigazione del re di Spagna de le isole et terreni novamente trovati. Venezia, 1504.
Pre-Linn. 1504.1

Contains the first printed account of fishing with the remora or guiacanum.

Copy, J. C. B. Reproduced in facsimile in Thacher, John Boyd. "Christopher Columbus," etc. N. Y., 1903, vol. II, chap. xv; and in Wiener, cited below.

—— [Fishing with the remora] (In Fracanzio, Montalboddo. Paesi novamente retrovati et Novo Mondo, da Alberico Vesputio Florentiæ intitulato. Vicenza, 1507. 120 leaves)
Pre-Linn. 1507.1

Second printed account.

A number of editions and versions of this work are known. Copies, 1508 (4 eds.), 1516, 1517, 1519, 1521, J. C. B.

"Fishing with the remora" also found in:

—— Legatio Babylonica, oceani decas [decade I], etc. Hispali [Seville], 1511.
Pre-Linn. 1511.1

—— De rebus oceanis et orbe novo decades tres, etc. Alcala, 1516.
Pre-Linn. 1516.1

This latter work, consisting of the three decades with or without the addition of the fourth and other decades, passed through a number of editions. Harris notes Italian and German editions of 1520. Others are known from Basel, 1521, & Cologne, 1522. Still others are 1530 (2 eds.), 1532, 1533, 1536, 1564 (Italian), 1574, 1577 (French), & 1582 (German). In 1534, at Venice, appeared a compilation an integral part of which was a summary of Peter Martyr's writings on the New World. This is reprinted in the 3rd vol. of Ramusio's "Delle Navigationi et Viaggi." (q. v.). The issue of Peter Martyr printed 1530 seems to have been a complete edition, and an edition of eight Decades is accorded to Paris, 1536, by some bibliographers, but apparently the first edition bearing the words "Decades octo" on the title page is:

—— De orbe novo Petri Martyris Anglerii mediolanensis, protonotarii et Caroli Quinti senatoris, decades octo, diligente temporum observatione et utilissimis annotationibus illustratæ, suoque nitore restitutæ labore et industria Richardi Hakluyti Oxoniensis, Arngli. Paris, 1587. Pre-Linn. 1587.1

This edition is dedicated to Sir Walter Raleigh: "illustri et magnanimo viro Gualtero Ralegho."

Later eds. are: Latin, Rotterdam, 1616, and its French translation, "Extrait ou recueil des îles nouvellement, etc." Another Latin version is "Opus epistolarum Petri Martyris," etc. Amsterdam, 1670. English versions follow:

—— Decades of the Newe Worlde, or West India; conteyning the navigations and conquests of the Spaniards . . . etc. Written in the Latine tongue by Peter Martyr of Angleria; and translated into Englyshe by Rycharde Eden, with Oviedo's Indies . . . etc. London, 1555.
Pre-Linn. 1555.1

Republished in Edwin Arber's book, "The first three English books on America." Birmingham, 1885.

A 2nd English ed. was published at London in 1577 under the title of "Rycharde Eden's History of Travayle in the West and East Indies [etc.] Augmented and finished by R. Willes."

In the 2nd ed., p. 211–215, is found the chapter on "Fishes, and of the manner of fishing," extracted from Oviedo.

A 3rd English ed. is Lok's extension of Eden, dated 1612. This was reprinted at London without date (*c.* 1625).

A present day admirable English version is:

De Orbe Novo: the eight decades of Peter Martyr d'Anghera translated from the Latin with notes and introduction by Francis Augustus MacNutt. 2 vols. N. Y., 1912. viii, 414 p. (I); 448 p. (II.) 8°.

Fishing with the remora, vol. I, p. 97; vol. II, p. 299–300. Fish rendered poisonous by eating manchineel, vol. II, 372. Methods of fishing on coast of Venezuela, vol. II, 378.

A modern Spanish edition was issued at Madrid, 1892, edited by Asensio. The authoritative French version is that edited by Paul Gaffarel, Paris, 1907.

The author of the "De Orbe Novo" was one of the foremost writers of his day on the natural and political history of the new world. His book, either in its parts or as a whole, passed through many editions, issues, and translations, and the preparation of his bibliography, even so far as it relates to fishes only, is a matter of great difficulty.

The great work of Peter Martyr in the do main of natural history was to make known to Europe the fauna and flora discovered by the Spaniards in the new world.

For critical notes on the origin of the word Guiacanum, and on the "fishing with the remora" story, *see* Wiener, L. "Africa and the Discovery of America." Philadelphia, 1920, vol. I, p. 61–67.

M[**ascall**] *L*[*eonard*] [–1589] A booke of fishing with hooke and line, and of all other instruments thereunto belonging, etc. Made by L[eonard] M[ascall] London, 1590. 93 p. 4°.
Pre-Linn. 1590.1

"The first part, containing the "Treatise of fishing" (clumsily taken and marred in the transfer from the "Book of St. Albans" ends at

Mascall, *L.*
p. 50 in the edition of 1590; the second part at p. 93." — W. & S.

Other eds. are: 1596, 1600, 1606.

Mascall was the pioneer fish culturist of England. For an analysis of his book and his plans for raising fish, *see* Marston, R. B. 1894.1. A modern reprint of the 1st edition with critical notes with reference to Mascall's sources, was issued under the editorship of T. Satchell in 1884. *See* Mascall, L. 1884.1.

Massarius, *Francisco.* Plinii libri II. de piscibus cum scholiis Joh. Cæsarii. a Franc. Massario, Veneto, explanati, quibus acc. Oppiani Halieuticon. Argentinæ, 1534. 4°. Pre-Linn. 1534.1

—— In nonum Plinii de naturali historia librum castigationes & annotationes. Quisquis de natura aquatilium ac remotiore piscium cognitione edoceri cupis, hunc Massarii commentarium eme & lege. Basilæ, 1537. 32, 367 p. 8°. Pre-Linn. 1737.1

Not seen; title from Bosgoed. Cuvier states that another ed., published at Paris (1542), contains both the ninth and thirty-second books of the Natural History, with commentaries by Massarius.

Massey, *William* [1691–1764] Observations upon the remora or sucking fish. Gentleman's Mag. & Hist. Chron. [Urban's], 1753, **23,** 162. — Dresden Mag., 1753, **1,** 7. St., no. 4. Pre-Linn. 1753.1

A review of the old literature.

Matthæus, —— (*respond.*) Dissertatio de anguillis. Medic. Siles. Satyra, Argentorati [Strasburg], 1673, **20.** 4°. Pre-Linn. 1673.1

Georg Frank von Frankenau, *præses.*

Not seen; title from Walbaum. Agassiz gives date, 1675. Walbaum & Boehmer say Heidelberg, 1675.

Mattheus, *Ant.* (*respond.*) Dissertatio de harengis, vulgo halecibus dictis. Groningiæ, 1649. 8°. Pre-Linn. 1649.1

Martin Schoock, *præses.*

Matthioli, *Pietro Andrea* [1500–1577] For biographical and bibliographical data, *see* Fabiani, Guiseppe. "La vita di Pietro Andrea Mattioli raccolta delle sue opere." Siena, 1872. x, 83 p. 8°.

—— Il Dioscoride dell' excellente Dottor P. A. Matthioli cō i suoi discorsi, con l'aggiunta dell sesto libro dei remedi di tutti i veleni de lui nuovamente tradotto & con dottissimi discorci per tutto commentato. Vinegia [Venice], 1548. Pre-Linn. 1548.1

Fishes and other animals, in book II.

This is the very rare 1st ed. It is sometimes dated 1544, that being the date of the "Privilegio." Other Italian eds. are: Mantua, 1549; Venice, 10 eds., 1544–1744.

—— Commentarii secondo aucti in libros sex Pedaci Dioscoridis de medica materia. Venetiis, 1552. fol. Pre-Linn. 1552.1

First known reference to fossil fishes of Monte Bolca, in introduction to book V.

4th Latin ed. Other eds. in Latin: Venice (10), 1558–1598; Basel, 1574 & 1598. Of these, the authoritative version (Artedi editor), is:

—— Commentarii in libros VI Pedacii Dioscoridis de medica materia, etc. Venetiis, 1565. clxx, 1459 p. ills. fol. Pre-Linn. 1565.1

Contains many figures of fishes copied from Rondelet and Salviani.

Foreign language versions; Lyons, 1572, 1578, 1620 (French); Salamanca, 1566 (Spanish). There are a number of German versions entitled "Kreuterbuch," etc., but as these seem to comprise only the botanical sections of Matthioli's commentaries, they are not included here.

—— Opera quæ extant, omnia. Francofurti, 1598. fol. Pre-Linn. 1598.1

Another ed., Basel, 1674. fol.

—— Degl' ittioliti del Bolca. Venezia, M. Gimani, 1621. Pre-Linn. 1621.1

Brocchi, in his "Conchiologia Fossile Subapennina," cites an edition of this work published in 1552.

Matthioli was a physician who practised at Rome, Trente, Carice, and Prague. His writings have to do with fishes mainly as articles of diet and for use in medicine. They have passed through many editions and translations.

Maurer, *Felix.* Von mancherlei Fischen und was sie im Wasser essen, auch ob sie Athem holen, sehen, hören, schreien. Observat. Curiosis. Phys., Frankfort, 1713, 457–482. Pre-Linn. 1713.1

Not seen. Title from Boehmer.

Maurice, *Count of Nassau-Siegen.* *See* **Nassau-Siegen,** *Johann Maurice* (*Count of*).

Maximilian II. *See* **Mercuriale,** *Girolamo.*

Medices, *Sebastianus.* Tractatus de venatione, piscatione et aucupio (In his Opera. Venice, 1586. fol.) Pre-Linn. 1586.1

—— The same. Separatim. Coloniæ [Cologne], 1588. 8°. Pre-Linn. 1588.1

Other separates: Helmstadt, 1592; Cologne, 1598; Marburg, 1698. Finally as:

—— The same (In Fritsch, A. Corpus juris venatorio-forestalis. Leipsic, 1702.) Pre-Linn. 1702.1

Copy, 1598 issue, N. Y. P.

Meichelbeck, —— [–*c.*1500] Geschichte des Alpenkloster Benediktbeuren im Walchensee (In Chronicon Benedictoburgæ. 1753. vol. I, p. 24.) Pre-Linn. 1753.1

According to J. Wimmer, in his "Geschichte des deutschen Bodens," p. 391–392, some account is given of Bavarian fishes.

Meier, *Joachim* [*c.* 1661–1732] Dissertationes epistolicæ de claris Fischerei, necnon de piscinis et piscatoribus, memorabilia quædam. Gottingæ. 1695. 4°. 5 pls. Pre-Linn. 1695.1

Menander, *Carl Frederick* (*præses*). Dissertatio de regia piscatura Cumoensi. Inaug. Dissert. Aboæ, 1751. 48 p. 2 pls. 4°. Pre-Linn. 1751.1

Fred. Reinhold Brander, *respond.*

—— Ichthyotheologiæ primæ lineæ. Inaug. Dissert. Aboæ, 1751. 37 p. 4°. Pre-Linn. 1751.2

Nicolas Malm, *respond.*

Mengenberg, *Conrad von.* *See* **Konrad von Megenberg.**

Mentzel, *Christian* [1622–1701] Theatri rerum naturalium Brasiliæ, tomus I continens icones aquatilium. 1660. Pre-Linn. 1660.1

Labelled also "Libri Picturati A. 32-33-34-35." These oil paintings of the natural objects of Brazil, are preserved in the great library of Berlin. They were painted by George Marcgrave, Franz Post and other Dutch artists in Brazil, 1638–44, under Count Maurice of Nassau-Siegen. They were collected and arranged in order, by Dr. Mentzel (court physician to the Elector of Brandenburg, *c.* 1660), who wrote a preface to them and had them bound up in huge volumes with an illuminated frontispiece — probably of his own designing. Vol. I contains the fishes, 357 in number. Some of these paintings have notes in the handwriting of Count Maurice. For further data on their history, *see* Gudger, E. W. "George Marcgrave, etc." (Add. 1912.1). *See* also Post, Franz, this section.

—— De stagno admirando Borussiæ alternis triennis sponte piscoso et frugifero. Misc. Acad. Nat. Cur., 1686, dec. 2, 4. Pre-Linn. 1686.1

Mercklein, *Georg Abraham* [1644–1702] Neu aussgefertigtes historisch-medicinalisches Thier-Buch, in vier Theilen verabfasset; deren handelt . . . III. Von Fischen und denen davon in der Medicin brauchbaren Dingen, etc. Nürnberg, 1696. xxiv, 732, 72 p. 96 pls. 8°. Pre-Linn. 1696.1

1st ed.; 2nd & 3rd, Nuremberg, 1714 & 1739. These are probably close reprints of the first; the third having the same number of pages.

Mercuriale, *Hieronymus* [*Girolamo*] [1530–1606] De arte gymnastica libri sex. In quibus exercitationum omnium vetustarum genera, loca, morte facultates, & quid quid de niq. ad corporis humani exercitationes pertinet, diligenter explicatur. . . . Ad Maximilianum II. Imperatorem. Venetiis, 1573. xii, 308, xxiv p. figs. 8°. Pre-Linn. 1573.1

Fishes, p. 181.
2nd ed. with many figs. added. Title from Hecksher sale catalogue.

Merian, *Maria Sibilla,* afterwards **Graff.** [1647–1717] Dissertatio de generatione & metamorphosibus insectorum Surinamensium . . . item appendix transformationum piscium in ranas & ranarum in pisces. Amsterdam, 1719. fol. pls. Pre-Linn. 1719.1

The 1st ed. of the "Metamorphosis Insectorum Surinamensium" was issued Amstelodami, 1705 in two texts, Latin & Dutch. The 1719 ed. also appears in Dutch. A third ed. in Latin appeared in 1726, & a Dutch version of it in 1730. Some copies have Latin and French in parallel columns, others Latin & Dutch.

Interesting as the first known reference to the fact that the tadpole is a stage in the transformation of fishes into frogs. *See* also Cappeler, M. A. Add. 1767.1.

Merrett, *Christopher* [1614–1695] Pinax rerum naturalium Britannicarum continens vegetabilia, animalia et fossilia, in hac insula reperta inchoatus. Londini, 1666. xxviii, 221 p. 8°. Pre-Linn. 1666.1

This contains some notes on fishes.
Other eds.: London, 1667 & 1704. 8°.

Meulen, *S. van der* [*fl.* 1700] Groote vissery. Amsterdam, [*c.* 1700]. Pre-Linn. 1700.1

Contains 16 engravings by Adrian van der Laan, from drawings by Van der Meulen and others (all relating to the herring fishery).

Meurer, *Noe.* Wasser-Recht, fürnehmlich des weitberühmbten und goltreichen Rheinstroms, . . . Item von . . . Salmen. Cöllen [Colle], 1563. 4°. Pre-Linn. 1563.1

Fishes, p. 112–115.

—— Jag und Forstrecht, . . . auch den Wildtbanen, Fischereyen und was solchen anhangt. Franckfurt, 1582. 189 leaves. fol. Pre-Linn. 1582.1

"189 folios, the first four of which are not numbered. Printed by Peter Schmid, in 1581 and containing engravings by Jost Amman, chiefly from the "Jag und Weydwerck Buch," also published by Feyerabends, to which this volume closely corresponds in size, type, paper and illustrations." — W. & S.
Another ed., Marburg, 1618. 270 p. fol.

—— Tractatus juridicus de alluvione insulis, alveo et jure aquatico oder vom Wasser-Recht. Nürnberg, 1733. 8°. Pre-Linn. 1733.1

Meyer, *Johann Daniel.* Angenehmer und nutzlicher Zeitvertreib mit Betrachtung curioser Vorstellungen allerhand kriechender, fliegender, und schwimmender aus dem Land und Wasser sich befindender und nährender Thiere, so wohl nach ihrer Gestalt und äusserlichen Beschaffenheit, als auch nach der accuratest davon verfertigten Structur ihrer Scelette oder Bein-Körper, nebst einer physikalisch und anatomisch, besonder aber osteologisch und mechanischen Beschreibung der selben nach der Natur gezeichnet, gemahlet und in Kupfer gestochen. 3 vols. Nürnberg, 1748–56. 240 pls. fol. Pre-Linn. 1748.1

This work, by a painter of Nuremberg, consists of fine figures of fishes arranged without order. The accompanying text is very poor. Issued in parts: I, 1748. 100 copper plates; II, 1752. 100 pls.; III, 1756. 40 pls. Reviewed in Comm. de Rebus, 1748, **2**, 83.

Moehring, *Paul Heinrich Gerhard* [1710 *or* 20–1792] Rajæ clavatæ auctorum adfinis. Acta Acad. Leop. Carol. Nat. Cur., 1742, **6**, 483–484. Pre-Linn. 1742.1

—— Raja varia, corpore medio glabro, cartilagine transverso in dorso et ventre, triplici aculeorum ordine in cauda. Acta Acad. Leop. Carol. Nat. Cur., 1742, **6**, 485–486. Pre-Linn. 1742.2

—— Raja varia, dorso medio glabro, unico aculeorum ordine in cauda. Artedi, Ichthyol. gen. 37. syn. 102. Acta Acad. Leop. Carol. Nat. Cur., 1742, **6**, 482–483. Pre-Linn. 1742.3

Moffett, *or* **Moufet** *or* **Muffet,** *Thomas* [1553–1604] Insectorum sive minimorum animalium theatrum: olim ab E. Wottono, C. Gesnero, T.que Pennio inchoatum: tandem T. Moufeti . . . opera . . . concinnatum, auctum, perfectum; et ad vivum expressis iconibus . . . illustratum. Londini, 1634. xx, 326 p. illust. fol. Pre-Linn. 1634.1

Contains 2 excellent figures of Hippocampus, the male having the brood pouch well developed. Copy, A. M. N. H.

—— The same. English version. (In Topsell, Edward. History of foure-footed beastes, etc. London, 1658. p. 889–1130). Pre-Linn. 1658.1

Monro, *Alexander* (*primus*) [1697–1767] An essay on comparative anatomy. London, 1744. 138 p. 8°. Pre-Linn. 1744.1

Published anonymously by the first of three anatomists of this name, and believed to be one of the earliest formal treatises on the subject.

See also Severinus, M. A. in this section. Several times republished: first as, "The anatomy of the human bones, nerves . . ., to which is added his treatise of comparative anatomy," etc. 2 vols. Edinburgh, 1785; second, as "Traité de l' anatomie comparée, etc." Paris, 1786; also included in Walbaum, J. J. "Petri Artedi Renovati. Pars. II. Philosophia Ichthyologica." Grypeswaldiæ, 1789, 184–192; also in "The works of Alexander Monro, M. D. (primus), with the life of the author." Edinburgh, 1781. pls. 4°.

Translated into German, as "Sämmtliche Werke" with the "Vergleichenden Anatomie" annexed, Leipzig, 1782; and the latter published as a separate brochure at Göttingen, 1790. Finally the treatise on comparative anatomy was published at Edinburgh, 1791, as an appendix to "A system of anatomy and physiology with the comparative anatomy of animals," etc. compiled by A. Fife (chiefly from the works of A. Monro, primus) and revised by J. Rotherham.

See also Monro, A. (secundus), 1785.1.

Montanus, *Arnoldus* [–1687] Gedenkwaerdige gesantschappen der Oost-Indische maatschappy in 't Vereen. Nederland, aan de Kaisaren van Japan, . . . beschryving van dieren, . . . etc. Amsterdam, 1669. viii, 471 p. pls. fol. Pre-Linn. 1669.1

Japanese fishermen & fishing, p. 55 & 279. figs.

This was often republished and translated.

—— De nieuwe en onbekende Weereld; of beschryving van America en 't Zuid-land, etc. Amsterdam, 1671. fol. Pre-Linn. 1671.1

This compilation contains data on fishes and fishing in the new world. Translated, it appeared as:

—— America, being the latest and most accurate account of the New World, etc. London, 1671. Pre-Linn. 1671.2

J. Ogilby's version. *See* 1671.1.

Montalembert, *René* (*Marquis de*) [1714–1800] [Observation sur la fontaine de Gabard en Angoumois, dans laquelle on trouve des brochets aveugles et ceux qui sont borgnes, le sont tous de l'oeil droit.] Mém. Acad. Sci. Paris, 1748, hist., 27–28. Pre-Linn. 1748.1

Moor, *Bartholomæus.* De piscium et avium creatione oratio habita pridie Idus Aprilis Harderovici MDCCXVI. Harderovici [Harderwijk], 1716. 68 p. 4°. Pre-Linn. 1716.1

Not seen. Date according to Agassiz, Bosgoed, Carus & Engelmann. Boehmer, and Gronow say 1721.

Moore, (*Sir*) *John.* England's interest, or the gentleman and farmer's friend, with the angler's sure guide. Instructions for ordering of fish ponds, and for the increasing of fish. London, 1703. 166 p. 12°. Pre-Linn. 1703.1

2nd ed. (1st undated); others: London, 1705, 1707, 1721. The last, augmented, is:

—— The angler's guide. Instructions for the profitable ordering of fish ponds, and for the increase of fish, and a guide for young anglers, teaching them the best method of catching trout, carp, barbels, jacks, pikes, perch, roach, dace, etc. London, 1721. 12°. Pre-Linn. 1721.1

Mor de Nigro Monte, *Georgius.* Tractatus novus, elegans, omnium pulcherrimus et doctissimus de jure venandi, aucupandi et piscandi. Spiræ, 1602. vi, 144, xvi p. 4°. Pre-Linn. 1602.1

Other eds.: Spiræ, 1605, 1612, 1692. Also found in Fritsch, A. Pre-Linn. 1702.1.

Morand, *Sauveur* [1697–1773] Observation sur une carpe dans la quelle on voyoit distinctement d'un côté les oeufs et de l'autre la laite. Mém. Acad. Sci. Paris, 1737 (1740), hist., 51–52. Pre-Linn. 1740.1

Morhard, *Joan.* Tractatus de miraculis . . . Argentinæ, 1631. 4°. Pre-Linn. 1631.1

Liber III. De piscibus, p. 202; de piscibus ingentis magnitudinis, p. 205; de piscibus magnis, p. 208; de piscibus in aquis dulcibus, p. 216.

Moriggia, *Paolo.* Historia della nobiltà et degne qualità del Lago Maggiore, nella quale si descrive dove nasce il fiume Tecino e sua uscita; con la lunghezza e larghezza del Lago, e tutte le sorti di pesci ch' egli produce. Milano, 1603. 8°. Pre-Linn. 1603.1

Moritz, *Count of Nassau-Siegen, see* **Nassau-Siegen,** *Johann Maurice (Count of).*

Moro, *Anton Lazzaro* [1687–1764] De' crostacei e degli altri marini corpi che si truovano su' monti. Libri due. Venezia, 1740. 8 pls. Pre-Linn. 1740.1

"Parla dei pesci marini che si truovano sul Bolca monte del Veronese e spiegasi come sienovi andati." Dal Nero.

Mortimer, *Cromwell* [–1752] An account of Mr. Mark Catesby's essay towards the natural history of Carolina and the Bahama Islands, with some extracts out of the sixth and seventh setsfishes [!]. Phil. Trans. Roy. Soc. London, 1734 (1735), **38,** 315–318. *Ibid.*, 1735 (1738), **39,** 112–114. Pre-Linn. 1735.1

—— Index piscium in Ichthyographia Willughbyana vel descriptorum vel depictorum, eorum nominum Anglicanorum, Belgicorum, Germanicorum, Gallicorum, Italicorum, Lusitanicorum, etc. Additis synonymis per varias Magnæ Britanniæ provincias usitatis, etc. (In Willughby, F. De historia piscium libri quatuor, etc. Londini, 1743.) 1740, 12 p. fol. Pre-Linn. 1740.1

The printers' subscription at the end of this paper bears date, 1740. The Dictionary of National Biography expressly states that Mortimer prepared this index especially for the 1743 edition of Willughby. Evidently there was some delay in issuing the whole volume, hence the discrepancy in dates.

—— [An account of the horn of a swordfish struck several inches into the side of a ship]. Phil. Trans. Roy. Soc., 1741 (1744), **41,** pt. 2, 862–864. Pre-Linn. 1744.1

—— The description of a fish named *Opah guiniensium* [= *Lampris guttata*], shewed to the Royal Society by Mr. Ralph Bigland. Phil. Trans. Roy. Soc. 1750, **46,** 518–520. figs. Pre-Linn. 1750.1

Mortimer, *J.* [*c.* 1656–1736] The whole art of husbandry, or, the way of managing and improving of land, etc. By J. M. Esq., London, 1707. 8°. Pre-Linn. 1707.1

Book VI. chap. 21. "Of fish-ponds, how to store, manage and order them for each sort of fish, etc."

Other eds.: London, 1712, 1716, 1721; 1753 (German); 1765 (French).

Morton, *John* [*c.* 1671–1726] The natural history of Northamptonshire; etc. London, 1712. 597 p. 14 pls. fol. Pre-Linn. 1712.1

Fishes, p. 418–423.

Morton, *Thomas* [*c.* 1590–1646] New English Canaan; or New Canaan, containing an abstract of New England. Composed in three bookes. . . . II. The natural indowments of the countrie, & what staple commodities it yeeldeth, etc. 1632. Pre-Linn. 1632.1

"Of the fishes, and what commodity they prove."

Reprinted in Force's Historical Tracts, **2,** tract 5. Extracts in Rept. U. S. Fish Comm. 1871–72 (1873), 157–159.

Moscardo, *Ludovici.* Note overo memorie del Museo del Conte Lodovico Moscardo, etc. Padua, 1656. Pre-Linn. 1656.1

1st ed. Monte Bolca fishes, p. 182.

Moscardo, *L.*

—— The same, 2nd ed. 2 vols. [in 1] Verona, 1672. figs. fol. Pre-Linn. 1672.1

Vol. I, fossil fishes, p. 182, figs.; recent fishes, 224–231, figs.

Moufet, *Thomas. See* **Moffett,** *Thomas.*

Müller, *W. J.* Die Africanische auf der Guineischen Goldcust gelegene Landschaft Fetu. Nürnberg, 1675. pls. 8°. Pre-Linn. 1675.1

Fisheries, 219–240.

Münster, *Sebastian* [1489–1552] Cosmographia, Beschreibung aller Länder, etc. Basel, 1543 [or –44]. fol. Pre-Linn. 1543.1

First issue of a popular work which passed through many eds. Some are: Basel, 1545, 1550 & 1552; and (Germ.) Basel, 1578 & 1621: — all sm. fol. The most prized ed. is the 1550. Copies, 1552 ed. Col. & N. Y. P. Seen by us is:

—— Cosmographiæ universelle lib. VI. Basiliæ, 1552. Pre-Linn. 1552.1

Contains some data on fish and fishing.

Muffet, *Thomas. See* **Moffett,** *Thomas.*

Muralt, *Johannes von* [1645–1737] Examen anatomicum *Mustelæ fluviatilis.* Ephemer. Acad. Nat. Cur., 1682 (1683), ann. 1, 124–128. — Amphitheatrum Zootomicum. (Valentini, M. B.), 1720, pt. 2, 132–133. Pre-Linn. 1683.1

—— Examen anatomicum trutta magnæ. Misc. Acad. Nat. Cur., 1682 (1683), dec. 2, ann. 1, 128–129. — Amphitheatrum Zootomicum. (Valentini, M. B.), 1720, pt. 2, 121–122. Pre-Linn. 1683.2

—— Exercitationes medicæ, observationibus et experimentis mixtæ. Amstelodami, 1688. 12°. Pre-Linn. 1688.1

Anatomy of Mustela and Anguilla.

—— Zoologia seu animalium contemplatio physica, philosophiæ et medicinæ studioses pernecessaria. Tiguri [Zurich], 1709. 382 p. 8°. Pre-Linn. 1709.1

Contains data on Swiss fishes.

—— Zoologiæ continuatio de avibus, piscibus, serpentibus et insectis. Tiguri, 1709–10. 8°. Pre-Linn. 1709.2

Musgrave, *William* [*c.* 1655–1721] An account of some experiments relating to digestion and of a large bed of glands observed in the stomach of a jack [fish]. Phil. Trans. Roy. Soc., 1684, **14,** 699–701. 2 figs. Pre-Linn. 1684.1

Musurus, *Marcus* (*Archbishop of Malvasia*) (*editor*) [1470–1517] Oppianou 'Alieutikon biblia pente. Oppiani de natura seu venatione piscium libri quinque [Edited by M. Musurus]. Florentiæ, 1515. 8°. Pre-Linn. 1515.1

See also Oppian, Pre-Linn. 1515.1.

Mylius, *Gottlieb Friedrich* [1675–1726] Memorabilium Saxoniæ subterraneæ i. e. Des Unterirdischen Sachsens seltsamer Wunder der Natur, etc. 2 vols. Leipzig, 1709–1718. 80 & 89 p. 44 pls. 4°. Pre-Linn. 1709.1

In vol. I, certain fossil fishes are figured and described.
2nd ed., Leipsic, 1720.

N

N. Voyages au côtes de Guinée & en Amérique. Amsterdam, 1719. 416 p. illust. Pre-Linn. 1719.1

Marine fishes of Guinea, p. 69–70. pl. Fight between swordfish and whale, p. 69. Fishes of St. Thomas, p. 152–160. 3 pls. Manta, p. 157–160. fig.
Copy, A. M. N. H.

Nassau-Siegen, *Johann Maurice* (*Count of*) Governor-general of Dutch Brazil, 1637–1644. Friend and patron of Marcgrave and Piso in their work on the natural history of Brazil, and possibly joint painter with Marcgrave of the plants and animals illustrated in the "Historia Naturalis Brasilia." *See* hereon, "George Marcgrave," etc., by E. W. Gudger, Add. 1912.1. Also Mentzel, Christian, & Post, Franz. (This section.)

Neck, *Jacob Cornelisz van.* Journal ofte dagh-register . . . dor de acht shepen van Amsterdamme, onder . . . Jacob Cornelisz Neck . . . ende Wybrandt van Warwick . . . in den jare 1598, etc. Amsterdam, 1600. 40 folios & append. obl. 4°. Pre-Linn. 1600.1

Fishing scene at isle of Mauritius, folio 6, pl. 2; at Gammelamme, folio 35, pl. 15.

—— Het tweede boeck, journael ofte dagh-register, etc. Middelburch, 1601. 50 folios & append. obl. 4°. Pre-Linn. 1601.1

Fishing scene at Mauritius, folio 7. City of Gammelamme with fishing scene, folio 40, pl. 15.
Other eds.: Amsterdam, 1601 & 1608. Versions in other languages are:

—— Le second libre, journal ou comptoir; contenant le vray discours et narration historique, du voyage fait par les huit navires d'Amsterdam . . . sous la conduite . . . Nec & . . . Warwick. Amsterdam. 1601. fol. Pre-Linn. 1601.2

Another ed., Amsterdam, 1609.

—— A journal, or dayly register of the voyage accomplished by six [eight] ships of Amsterdam to the East Indies. London, 1601. 4°. Pre-Linn. 1601.3

—— Historiale beschryvinge, inhoudende een waerachtig verhael . . . acht schepen vom Amsterdam. Amsterdam, 1619. Pre-Linn. 1619.1

All the above in N. Y. P. For other versions (not seen by us and not known to contain the data cited above), consult P. A. Thiele. Add. 1867.1

Neckham, *Alexander* (*Abbot of Cirencester*) [1157–1217] De naturis rerum libri duo. [MS. *c.* 1180] Pre-Linn. 1180.1

Edited by Thos. Wright and published under the direction of the master of the rolls in "Chronicle & Memorials of Great Britain & Ireland in the Middle Ages." London, 1863, **34**, lxxviii, 521 p. *See* Wright, Thomas. 1863.1.
Book II, chaps. 22–46, treat of fishes; chap. 47, of the construction of a fishing net.

Needham, *John Turberville* [1713–1781] An account of some new microscopical discoveries . . . Likewise observations on the supposed embryo of the sole-fish fixed to the bodies of shrimps, etc. London, 1745. vii, 126 p. 6 pls. 8°. Pre-Linn. 1745.1

"On the supposed embryo of the sole-fish fixed to the body of shrimps," pt. IV. Egg of the ray, chap. 10.
First issued under initials N., T. Second issue (also 1745) bore author's name.

—— Nouvelles découvertes faites par le microscope, etc. Leide, 1747. 8 pls. 8°. Pre-Linn. 1747.1

The egg of the ray, p. 108.
Another French ed., Paris, 1750.

Needham, *Walther* [*c.* 1631–1691] Disquisitio de formato foetu. London, 1667. 12°. Pre-Linn. 1667.1

Republished, Amsterdam, 1668.
Respiration of fishes considered.

—— Descriptio anatomica Cyprini. (In Valentini, M. B. Amphitheatrum zootomicum Francofurti, 1720, pt. 2, 123–124. pl. 73.) Pre-Linn. 1720.1

—— Descriptio anatomica Lucii et Alosæ (In Valentini, M. B. Amphitheatrum Zootomicum, Francofurti, 1720, pt. 2, 122–123. pl.) Pre-Linn. 1720.2

—— De biolychnio & ingressu aeris in sanguinem.

Not seen by us. Our only reference from M. B. Valentini's "Amphitheatrum zoötomicum," 1720. (*q. v.*)

Nelson, *William* (*Barrister*) [*fl.* 1720] The laws of England concerning game. Of hunting, hawking, fishing, and fowling, etc. London, 1727. xx, 300 p. 18°. Pre-Linn. 1727.1

Other eds.: 1732, 1736, 1751, 1753, 1762.

Neucrantz, *Paul* [1605–1671] De harengo, exercitatio medica in qua principis piscium, exquisitissima bonitas, summaque gloria, asserta et vindicata. Lubecæ, 1654. 88 p. 4°. Pre-Linn. 1654.1

Nieremberg, *Juan Eusebio* [1595–1658] Historia naturæ, maxime peregrinæ, libris xvi. distincta. In quibus rarissima naturæ arcana, . . . & ignota Indiarum animalia, quadrupedes, aves, pisces, reptilia, insecta, zoophyta, plantæ, metalla, lapides, & alia mineralia, fluviorumque & elementorum conditiones, etiam cum proprietatibus medicinalibus describuntur; etc. Antverpiæ, 1635. 502 p. 50 leaves. figs. fol. Pre-Linn. 1635.1

Fishes, book XI.
Several editions in Spanish.
Copies, 3 eds., Arn.

—— Filosofia curiosa y tesoro de marviglias de la naturaleça. 2 vols. Madrit, 1637. 8°. Pre-Linn. 1637.1

—— Curiosa y occulta filosofia de las maravillas de naturaleça, que contiene historias muy notabiles — secretos y problemas de la naturaleça. Madrit, 1643. 8°. Pre-Linn. 1643.1

Another edition, apparently identical with the above, Barcelona, 1644. 8°.

Of this author, professor of physiology in the royal academy of Madrid, and of his book, Cloquet remarks: "Le jésuite Nieremberg, dans cet ouvrage qui n'est qu'une compilation sans goût et sans jugement, a montré de l'érudition, mais n'a avancé en rien l'histoire naturelle des poissons dont il a parlé, non plus que celle des autres objets dont il a traité dans son livre."

Nieuhof, *Joan* [*c.* 1610–1672] Het Gezantschap der Neerlandtsche Oost-Indische Compagnie aan den grooten Tartarischen Cham, den tegenwoordigen Keizer van China . . . 1655–1657, etc. Amsterdam, 1665. xii, 208, 258 p. 148 pls. ills. fol. Pre-Linn. 1665.1

Contains numerous notes on fishes.

Other eds.: Amsterdam, 1670, 1693. fol. Versions in various languages follow.

—— L'ambassade de la Compagnie orientale des Provinces Unies vers l'empereur de la Chine, etc. Amsterdam, 1665. Pre-Linn. 1665.2

Another French ed., Amsterdam, 1682.

—— Die Gesandschaft der Ost-Indischen Gesellschaft in den Vereinigten Niederländen an den Tartarischen Cham, etc. Amsterdam, 1666. iv, 444 p. 144 pls. fol. Pre-Linn. 1666.1

Other German eds.: Amsterdam, 1669, 1675; also found in Arkstee & Merkus, Allg. Hist. Reisen. 1749, vol. V.

—— Legatio Batavica ad magnum Tartariæ Chamum, etc. Amsterdam, 1668. Pre-Linn. 1668.1

—— An embassy from the East India Company of the United Provinces to China, etc. London, 1669. fol. Pre-Linn. 1669.1

—— Gedenkwaerdige zee en lantreize door de voornaemste lanschappen van West en Oostindien. 2 pts. [in 1] Amsterdam, 1682. xii, 240, lv, 308 p. fol. Pre-Linn. 1682.1

Descriptions & figures of 40 fishes, p. 268–281, part II.

Parts I & II were also separately issued under the following titles:

—— Gedenkweerdige Brasiliaense zee- en lant-reize . . . Beneffens een bondige beschryvingh van gantsch Neerlants Brasil. Amsterdam, 1682. pls. fol. Pre-Linn. 1682.2

—— Zee- en lant-reize, door verscheide gewesten van Oost-Indien . . . inzonderheit een wijtloopig verhael der stad Batavia. Amsterdam, 1682. 42 pls. fol. Pre-Linn. 1682.3

Another ed., 1693.

Forty fishes figured & described, p. 268–281.

English translations of Nieuhof's voyages to Brazil and the East Indies are found in abridged form in Churchill's "Voyages," 1704, vol. II; Pinkerton's "Voyages." 1811, vol. VII, and 1813, vol. XIV.

His notes on East Indian fishes have been collected as:

—— Pisces Indiæ Orientales [in] Appendix ad historiam naturalem piscium (In Willughby, F. De historia piscium, etc. Oxonii, 1686. fol. ills.) p. 1–7. Pre-Linn. 1686.1

Ninmero, *Jacobus* (*respond.*) Disputatio juridica de jure venandi, aucupandi et piscandi. Inaug. Dissert. Marpurgæ [Marburg], 1604. 3 pls. 4°. Pre-Linn. 1604.1

G. Antonius, *præses*.

Nobbes, *Robert* [1652 — *c.* 1706] The complete troller, or, the art of trolling. With a description of all the utensils, instruments, tackling, and materials requisite thereto: with rules and directions how to use them, etc. London, 1682. xx, 78 p. 8°. Pre-Linn. 1682.1

Other eds.: Norwich & London, no dates. Facsimile reprint, *c.* 1790. Later eds.: London, 1805 & 1814.

Noël, —— Mémorial alphabétique des matières des eaux et forêts, pesches et chasses. Paris, 1737. 4°. Pre-Linn. 1737.1

Nollet, *Jean Antoine* [1700–1770] Mémoire sur l'ouïe des poissons et sur la transmission des sons dans l'eau. Mém. Acad. Sci. Paris, 1743 (1746), 199–224. pl. Pre-Linn. 1746.1

Nonnius, *Ludovicus* [*c.* 1553–] Ichthyophagia sive de piscium esu commentarius. Antwerp, 1616. 176 p. 8 pls. 8°. Pre-Linn. 1616.1

A learned work which reflects the attitude of the physicians of the time.
Copy, A. M. N. H.

—— Diaeteticon, seu de re cibaria libri IV. Antwerpiæ, 1627. 8°. Pre-Linn. 1627.1

Other eds.: Antwerpiæ, 1633 & 1645.

North, *Roger* [1653–1734] A discourse of fish and fish-ponds. Done by a person of honour. London, 1713. 79 p. sm. 8°. Pre-Linn. 1713.1

Treats especially of culture of carp.
Osmund Lambert, in his "Angling literature in England," calls this "the principal English work of early date on fish-culture."
Other issues: London, 1714, 1715, & 1773. The last only has the author's name on the title-page. The "Discourse" was appended to his "The gentleman farmer," 1726; and to Albin's "Esculent fish," 1794. For this work and its 1835 reprint, *see* North, R., vol. II, p. 200. A French version is:

—— Traité des étangs, des viviers, des canaux, etc. Paris, 1717. Pre-Linn. 1717.1

Nozeman, *Cornelius* [–1786] Beschrijving van den rivier-harder [*Cyprinus dobula*]. Uitgez. Verh. 1757, **1,** 576–580. Pre-Linn. 1757.1

—— Beschryving van een ongemeenen inlandsen vis. [*Liparis barbatus.*] Uitgez. Verh., 1757, **1,** 581–584. figs. Pre-Linn. 1757.2

—— Beschrijving van een zeldzamen vis [Argentina sp.]. Uitgez. Verh., 1758, **3,** 381–386. figs. Pre-Linn. 1758.1

Nuenning, *Jodocus Herman,* & **Cohausen,** *J. H.* Commercii litterarii dissertationes epistolicæ historico-physico-curiosæ . . . de glossopetris, lapidibus cordiformibus, . . . cum utriusque historica bibliographia et præfatione epicritica S. E. E. Cohausen &c. 3 vols. Francofurti ad Mœnum, 1746–50. 8°. Pre-Linn. 1746.1

Nylant, *P.,* & **Hextor,** *J. van.* Schouw-tooneel der aertsche schepselen; afbeelding allerhande menschen, beesten, vogelen, visschen enz. Amsterdam, 1672. 3 vols. 160 pls. 4°. Pre-Linn. 1672.1

Translated into German as:

—— Schauplatz irdischer Geschöpffe worinnen allerhand Menschen, unvernünfftige Thiere, Vögel, Fische, und dergleichen, sampt Beschreibung ihrer Gestalt, Beschaffenheiten, Natur, Vermögen, Eigenschafften und Neigungen vorgestellet werden . . . etc. Osnabrück, 1678. 160 figs. 4°. Pre-Linn. 1678.1

Part IV: Die Abbildung und Beschreibung allerlei Fische, p. 237–308.

O

O., *D. C.* Acipenseris sive sturionis anatome. Nouv. Lit. Germ. Hamburg, 1703, 325. Pre-Linn. 1703.1

—— Observatio de sexu salmonum. Nouv. Lit. Germ. Hamburg, 1703, 364. Pre-Linn. 1703.2

Odoric of Pordenone (*Friar Beatus*) [*c.* 1286–1331] For brief sketches of Friar Odoric, *see* those by Henry Yule and C. R. Beazley in Encyclopædia Britannica (11th ed.), 1911, vol. XX; and by O. Hartig in the Catholic Encyclopædia, New York, 1911, vol. XII. Further biographies are referred to in these articles.

—— Odorichus de rebus incognitis. Pesaro, 1513. Pre-Linn. 1513.1

First ed. Reprinted in vol. II of Ramusio's "Naviatione e Viaggi," ed. (2nd) of 1574, and in the ed. of 1583. An early English version, probably the first, is:

—— Journall of Frier Odoricus . . . concerning strange things which he sawe among the Tartars of the East. (In Hakluyt, R. The principal navigations, voyages, trafiques and discoveries of the English nation. 1599, vol. II, p. 53–67.) Pre-Linn. 1599.1

This "Journal" passed through many editions and versions — too numerous to list here. The best eds. are those by Asquine, Udine, 1737; G. Venni. Venice, 1761; H. Yule ("Cathay and the way thither"), London, 1866, (Hakluyt Soc., Works, no. 36); & H. Cordier, Paris, 1891. An excellent English version (apparently a reprint of Hakluyt's 1599 edition) is:

The journall of Frier Odoricus, etc. (In Ashton, J. (editor). The voiage and travayle of Sir John Mandeville Knight. London, 1887. 289 p. 12°.) p. 221–265.

Fishes which cast themselves ashore, chap. VI. Fishing with the cormorant — earliest known reference, chap. IX.

For the latest English version known to us, *see* Odoricus of Pordenone (Friar), 1915.1.

Ogilby, *John* [1600–1676] America, being an accurate description of the new world, containing . . . their peculiar plants, beasts, birds and serpents. London, 1671. 675 p. 41 pls. Pre-Linn. 1671.1

Contains descriptions of various kinds of fishes, copied from earlier writers.
This is a translation of Montanus, Arnoldus. "De nieuwe en onbekende Wereld, etc." *See* Montanus, A., this section, 1671.1

Olafsen, *Jon.* Ichthyo-Graphia Islandica, eller underretning om de fiske som leve salt og ferskt vand udi Island sammen skreven i Kjöbenhavn anno 1737. 131 p. 4°. Pre-Linn. 1737.1

This valuable MS. to which reference is made by F. Faber in his "Naturgeschichte der Fische Islands," 1829, is in the library of the British Museum (Natural History).

Olaus Magnus. *See* **Magnus,** *Olaus.*

Oldmixon, *John* [1673–1742] The British empire in America, etc. 2 vols. London, 1708. 8°. Pre-Linn. 1708.1

Scattered notes on fishes throughout. Fishes of the Caribbean, vol. II, p. 176–180; 190–191.

Olearius, *Adam* [1600–1671] Moscovitische und Persianische Reisebeschreibung. Slesvic., 1647. fol. Pre-Linn. 1647.1

Other issues: Schleswig, 1656, 1663, 1671; Hamburg, 1669; Paris (French), 1656, 1659, 1679; Amsterdam, 1666, 1627, 1651 (Dutch); Utrecht, 1651 (Dutch). An English version is:

—— The voyages & travels of the ambassadors sent by Frederick, Duke of Holstein to the Great Duke of Muscovy, and the King of Persia. Begun in . . . 1633 and finish'd in 1639 . . . Whereto are added the travels of J. A. de Mandelslo . . . from Persia, into the East-Indies. Containing a . . . description of Indosthan, the Mogul's Empire, the oriental islands, Japan, China, &c . . . In III books . . . London, 1662. xxiv, 424, iv, 287 p. 4 pls. 7 maps. 4°. Pre-Linn. 1662.1

Fishes and fishing in Volga river and Caspian sea.
2nd ed. (Olearus only), London, 1669. Copy, N. Y. P.

—— Gottorffische Kunst-Kammer, worinnen allerhand ungemeine Sachen, so theils die Natur, theils künstliche Hände hervorgebracht und bereitet, vor diesem aus allen vier Theilen der Welt zusammen getragen, und vor einigen Jahren beschrieben. Schleswig, 1666. 88 p. 36 pls. obl. 4°. Pre-Linn. 1666.1

Second ed., Schleswig, 1674.
Ten fishes are described.

Oppian [*fl. c.* 172–210 A.D.] For an evaluation of Oppian's services to natural history, *see* Schneider, J. G. Add. 1783.1. For a biographical notice, *see* Martin, T. H. "Etudes sur la vie et les oeuvres d'Oppian de Cilicie." Paris, 1863. 8°. For further notices of Oppian's life and works, *see* in modern editions listed below.

—— De piscatu libri V. L. Lippius . . . traduxit. Colle, 1478. 64 leaves. 4°. Pre-Linn. 1478.1

The first edition of Oppian, and very rare.

—— Halieutika de natura seu venatione piscium lib. V. (Graece, edente M. Musuro). Florentiæ, 1515. 8°. Pre-Linn. 1515.1

The 1st ed. of the Greek text & very rare. *See* Musurus, M., this section.

—— De piscibus, L. Lippio interprete, lib. V [Text in Greek and Latin] Venetiis, 1517. 168 leaves. 8°. Pre-Linn. 1517.1

First edition in both languages. Very rare and valuable.

Three eds. of the above work were issued at Paris in 1555 by different publishers; one in Greek and two in Latin. One of the latter is a reprint of Lippius's 1478 translation. Other eds. are: Strasburg, 1534 & Paris, 1549. The former, a copy of which is in A. M. N. H., is entitled:

—— Oppiani poetæ Alieuticon, sive de piscibus, libri quinque e græco . . . Laurentio Lippio Collensi interprete, etc. Argentorati [Strasburg], 1534. Pre-Linn. 1534.1

A later ed. is entitled:

—— De venatione libri IV. de piscatu libri V. Lugduni Batavorum, 1597. 8°. Pre-Linn. 1597.1

Contains both Greek and Latin texts with notes and emendations by Conrad Rittershusius, and a list of writers on fishes. The best ed. is by J. G. Schneider. "De venatione lib. IV et de piscatione lib. V" [Greek and Latin] Strasburg, 1776. A second ed. was issued, Leipsic, 1813. In these eds. Schneider argues that the poems are by different Oppians.

Many other pre-Linnæan eds. are extant, but of these only two will be listed.

—— Halieuticks of the nature of fishes and fishing of the ancients, in V. books. Translated from the Greek, with an account of Oppian's life and writings, and a catalogue of his fishes, [by William Diaper and John Jones]. Oxford, 1722. 8°. Pre-Linn. 1722.1

The first two books treat of the nature of fishes and the others of the fishing of the ancients.

—— Oppiano della pesca, e della caccia tradotto dal Greco et illustrato con varie annotazioni da Anton Maria Salvini al Serenissimo Principe Eugenio di Savoja. Firenze, 1728. xvii, 510 p. 12°. Pre-Linn. 1728.1

Modern eds. in French & Italian are:

Les Halieutiques traduction du poème grec d'Oppian, où il traite de la pêche et des moeurs des habitants des eaux, par J. M. Limes. Paris, 1817. 8°.

Della pesca e della caccia; tradotto dal greco ed illustrato con varie annotazione da Antonmaria Salvini. Nuova ed., coll' aggiunta delle notizie sulla vita dell' autore per G. A. Greenhill. [Edited by Guilio Antimaco.] Milano, 1864. 16°.

Of all the ancient writers on fish and fishing, Oppian is easily the most important, His works on fishing have been so often translated, and so many times printed under varying titles, that it is difficult to set his bibliography in order. It seems not improbable that the works of two authors named Oppian have been confused. On this point, *see* Westwood & Satchell, 1883.1, p. 164, and note above concerning Schneider as editor.

Oribasius [*c.*325—*c.*400] Oribasii sardiani collectorum medicinalium, libri XVII, qui ex magno septuaginta librorum volumine ad nostram ætatem soli pervenerunt Ioanne Baptista Rasario, medico, Novariensi, interprete. Parisiis, 1555. Pre-Linn. 1555.1

Fishes as food in book II, chaps. 48, 49, 50, 51, 52.

Oribasius was physician to the emperor Julian. He largely copied Galen and Zenocrates as to the names of fishes and the properties of their flesh as aliment.

"**Ortus Sanitatis.**" *See Cube, Johann von (editor).*

Osbeck, *Pehr* [1723–1805] Beschreibung eines Fisches, Lotse genannt [*Naucrates ductor*]. König. Schwed. Akad. Abhandl., 1755, **17,** 72–75. Pre-Linn. 1755.1

See note under Kästner, A. G., above.

—— Beskrifning om en fisk [Naucrates], som kallas Lods. K. Svensk. Vetensk. Akad. Handl., 1755, **17,** 71–. Pre-Linn. 1755.2

—— Beschreibung eines Fisches, Mal [Silurus]. König. Schwed. Akad. Abhandl., 1756, **18,** 33–37. Pre-Linn. 1756.1

See note under Kästner, A. G.

—— Beskrifning öfver fisken Mal [Silurus]. K. Svensk. Vetensk. Akad. Handl., 1756, **18,** 33–37. pl. Pre-Linn. 1756.2

See also Osbeck, P. in vol. II.

—— Dagbok öfver en Ostindisk resa åren 1750–52, med anmärkningar uti naturkundigheten, frömmande folkslags språk, &c. (En Ostindisk resa til Suratte, China, &c. Fran 1750 . . .

Osbeck, *P.*
til 1752 . . . förättad af O. Toren &c.) Stockholm, 1757. vi, 376 p. 12 pls. 8°. Pre-Linn. 1757.1

16 species of fishes are described.

For German and English versions of 1765 & 1771, *see* Osbeck, P. in vol. II.

Oudenhoven, *Jac. van.* Out-Holland nu Zuyt-Hollandt. Vervangende een generale beschryvinge, mitsgaders de privilegien, keuren, hantvesten, enz. Dordrecht, 1654. 8°. Pre-Linn. 1654.1

Contains considerable data on fish and fisheries, p. 28–34, 54, 275, 374.

Ovid, (Publius Ovidius Naso) [43 B. C.–17 A. D.]. For a sketch of Ovid's life and a list of works and editions, *see* Owen, S. G. in Encyclopædia Britannica, 11th ed., 1911, vol. XX, 386–390.

—— Opera. Rome & Bologna, 1471. Pre-Linn. 1471.1

Two separate eds. Numerous other eds. were published ante 1758, but only the following will be listed here: Venice, 1474 (H. E. H.); Milan, 1477, Parma, 1477 (H. E. H.); Vicenza, 1480 (H., S. C.); Venice, 1486 (H. W.).

Indexed in the Opera is: "Halieutica." This poem is included among the works of Ovid, but the authorship is attributed by some critics to Gratius Faliscus. Names are given of 53 kinds of fishes, and the list was published by Conrad Gesner in 1556 at Zurich with attempted identifications. Two editions may be listed here; the second by Gesner.

—— Halieuticon poematicum Ovidii Nasonis. Lugduni, 1535. Pre-Linn. 1535.1

—— Halieuticon: hoc est, de piscibus libellus, multo quam antehac emendatior et scholiis illustratus . . . per Conradum Gesnerum. Tiguri [Zurich], 1556. 8°. Pre-Linn. 1556.1

"A fragment of 134 hexameters, formerly ascribed to Ovid, which will also be found in 'Gratii poetæ . . . de venatione,' 1534 & 1537; Lonicer, J. A. 'Venatus et aucupium,' 1582; and Lemaire N. E. 'Bibliotheca classica Latina,' 1819, etc., vol. CXXXIV. It has been critically examined by Theodor Birt, and pronounced a thistle intruding among the poet's flowers, in 'De halieuticis Ovidis poetæ falso adscriptis,' p. iv & 207. Berolini, 1878. 8°. The verses are also contained in 'Halieutica . . . ex recensione M. Hauptii.' Berlin, 1838." — Westwood & Satchell.

Oviedo y Valdez, *Gonzalo Fernandez de* [1478–1557] For some account of the man and his work, *see* Miall, L. C., 1912.1.

—— Relacion sommario de la natural historia de las Indias. Toledo, 1525. fol. Pre-Linn. 1525.1

This, Oviedo's first work, was also issued in Italian, Venice, 1535. A modern reprint is: "Sumario de la natural historia de las Indias" (In "Biblioteca de autores españoles." Madrid, 1852, **22**, 471–515.)

—— Oviedo de la natural hystoria de las Indias, etc. Toledo, 1526. lij. 2 leaves. fol. Pre-Linn. 1526.1

For an elaborate disquisition on this work, *see* Harisse's "Bibl. Amer. Vet.," no. 139. *See* also J. R. Bartlett's "Catalogue of John Carter Brown's Library," and Ternaux's "Bibliothèque Americaine," no. 35. The text of Oviedo has been republished in Barcias' "Historiadores Primitivos," vol. I, and in the "Bibliotheca de Autores Españoles," vol. IV. An Italian version is included in Ramusio, vol. III, p. 44–74, and a summary in English will be found in Purchas, vol. III, p. 970, etc. A modern English reprint was published by Edward Arber in 1885. Probably the best edition of Oviedo is:

—— Historia general y natural de las Indias, islas y tierra firme del mar océano, por el Capitan Gonzalo Fernandez de Oviedo y Valdés. Sevilla, 1535. 4 leaves, i–cxciij. Pre-Linn. 1535.1

Oviedo's excellent history passed through a large number of editions and translations. Of these, Spanish eds. are, Seville, 1535; Salamanca, 1541, & 1547 under the title "Coronica de las Indias"; & Valladolid, 1557. In French, eds. were issued at Paris, 1555 & 1556; in Italian, 1556, 1561, & 1606 in Ramusio's collections.

Oviedo's "Historia natural" comprises 50 books. The "Sommario" of 1525 and the "Hystoria" of 1526 must be accounted as preliminary issues. The Seville "Historia" of 1535 comprised 19 books, and the 20th, completing the first section of the general work, is found in the Valladolid edition of 1557. The complete work was first published by the Real Academia de la Historia, Madrid, 1851–55. 4 vols. 4°.

Oviedo lived for twenty years in America, and his accounts of the fishes and other animals of the New World are among the best written at that time. His description of fishing with the remora is by far the most circumstantial and accurate of any of the early Spanish writers.

Copies of nearly all of Oviedo's works and editions are in N. Y. P.

An early English version is:

—— Certeyne notable thynges gathered owte of G. F. Oviedus his book entiteled the summarie of his generall hystorie of the West Indies, by Richard Eden. London, 1555. 4°. Pre-Linn. 1555.1

Printed with Eden's version of Peter Martyr's "Decades," and like the latter reprinted in Edward Arber's "The first three English books on America." Birmingham, 1885.

Ovington, *John* [*fl.* 1689–1698] A voyage to Surratt, in the year 1689. London, 1696. 606 p. Pre-Linn. 1696.1

Fishes, p. 36, 45–49. Sleep of fish, p. 48. Fish fed to cattle, p. 425.

A French version is:

—— Voyages faits à Surate, etc. 2 vols. 1725. xxiv, 323: 318 p. 12°. Pre-Linn. 1725.1

A Dutch edition appeared in 1729. The "Voyage" was also republished in Arkstee & Merkus, "Allg. Hist. Reisen," 1748, Bd. X.

P

Paciersio, *Giacomo.* Theatro della caccia et trattenimento geniale della villa. Nel quale si contiene la maniera, et arte d'uccellare, pescare, etc. Milano, 1669. iv, 100 p. Pre-Linn. 1669.1

With rude woodcuts. "Altra regola di pescare con la canna, et sedarina," p. 40–46.
Another ed., Bologna, 1673.

Palladius, *Rutilius Taurus Aemilianus* [*fl.* 4th cent.] De re rustica libri XIV. Parisiis, 1543. 8°. Pre-Linn. 1543.1

This work, which treats of fish and fishponds, is in the form of a farmer's calendar, and is mainly a compilation of Columella (*q. v.*) and other early writers on farming and fish rearing.
It is included in "Scriptores rei rusticæ" in various editions from 1472–1794, and in "Poetæ Latines minores" edited by Wernsdorf, 1794. *See* also Gesner, J. M., 1735.1.
It also appeared in many versions: Italian, Venice, 1528, 1560, & Verona, 1810; French, Paris, 1553 or 54, & 1844; German, Magdeburg, 1612; English (by T. Owen), London, 1803.

Palladius, *Rutilius Taurus Aemilianus,* **Cato,** *M.,* & **others.** Libri de re rustica. Parisiis, 1533. 506 p. fol. Pre-Linn. 1533.1

Other eds.: Paris, 1543; Lugduni, 1549; Leipsic, 1794–95.
See also Cato, M., Varro, M. T., & others, Pre-Linn. 1533.1.

Panarolli, *Dominici.* Iatrologismorum seu observationum pentecostæ quinque, etc. Hanoviæ, 1654. Pre-Linn. 1654.1

Anguillæ jecur nyctalopes sanans, p. 104–105. Nympha monstrosa torpedinem repræsentans, p. 111.

Paravicinus, *Basil.* Del vivere delli Romani e di conservar la sanita de M. Alessandro Petronio Libri v. dove si tratta del sito di Roma, dell' aria, de' venti, dell' aque, de' vini, delle carni, de' pesci, di frutti, delle herbe e di tutte l'altre cose pertinenti al governo degli huomini, tradotti della lingua latina nella vulgare. Roma, 1592. 4°. Pre-Linn. 1592.1

Paré, *Ambroise* [1510–1590] Oeuvres complètes d'Ambroise Paré. Paris, 1575. Pre-Linn. 1575.1

The 1st ed. This very valuable work passed through 11 other French, 6 Latin, 6 English, 5 Dutch, and 5 German eds.; the latest French issue appearing in 1685. Most available today in the 3 volume ed., Paris, 1840–41, copy of which is in N. Y. P.
In vol. III of this ed., Venins de la torpille, p. 318; murène, p. 330; pastenaque, p. 332; unicorn (Xiphias & Gladius), p. 502–503. "La livre des animaux" contains little on fishes; but "Monstres marines" deals with a number of fish forms.
The section on poisons first appeared in the 1575 ed.; that on animals in 1579, while dates cannot be here given for the sections on marine monsters and the unicorn.

Parsons, *James* [1705–1770] Some account of the *Rana piscatrix* [*Lophius*]. Phil. Trans. Roy. Soc., 1749 (1750), **46,** 126–131. figs. Pre-Linn. 1750.1

Pasini, *Antonio.* Annotationi & emendationi nella tradottione dell' eccell. P. A. Matthioli de' cinque libri della materia medicinale di Dioscoride Anazerbeo. Bergamo, 1591. vi, 252 p. 4°. Pre-Linn. 1591.1

Spanish & German eds.: Salamanca, 1586, & Frankfort, 1614. *See* also Dioscorides, & Matthiolus, in this section.

Passeri, *Giambattista* [1694–1780] Dissertatio de petrificatis agri Veronensis. Venetiis, 1753. 12°. Pre-Linn. 1753.1

—— Istoria de fossili del pesarese e d' altri luoghi vicini, dissertatione I, nella quale si riferisce la storia della maggior parte de fossili, che nel territorio de quella citta si ritrovano. Pesaro, 1753. 12°. Pre-Linn. 1753.2

Eocene fishes of Monte Bolca.
Another ed., Bologna, 1775. (Agassiz.)

Paullini, *Christian Franz* [1643–1712] De singulari monstro marini. Ephemer. Acad. Nat. Cur., 1677, dec. 1, ann. 8, 79–80. Pre-Linn. 1677.1

Jonah and the fish called Lamia.
See also, Pfeiffer, S. A. this section.

—— Cœnarum Helena, seu anguilla, juxta methodum et leges illustris Academiæ Naturæ Curiosorum, descripta, selectisque; observationibus et curiositatibus condita. Francofurti & Lipsiæ, 1689. 200 p. pl. 12°. Pre-Linn. 1689.1

Found also in Misc. Acad. Nat. Cur., 1695 & 1696, ann. 3 & 4, p. 115. Abstract in Valentini, M. B. "Historia litteraria . . . Academiæ Natura Curiosorum, etc." Gissæ Hassorum, 1708.

Paullini, *C. F.*

—— De ovo quadrato. [Egg of ray or shark] Misc. Acad. Nat. Cur., 1701 & 1702, dec. 3, ann. 9 & 10, obs. 53, p. 85. Pre-Linn. 1701.1

Peacham, *Henry* [*c.*1576–1643] The compleat gentleman . . . also certain necessarie instructions concerning the art of fishing. London, 1627. sm. 4°. Pre-Linn. 1627.1

Other eds.: 1634 & 1661.
Use of fish in heraldry in 1634 ed.

Pechlin, *Johannes Nicolaus* [1646–1706] Piscem Jonæ deglutitorem non fuisse balaenam. Lubec, 1697. 4°. Pre-Linn. 1697.1

Perrault, *Claude* [1613–1688] For biographies, *see* Gaz. Med., Paris, 1848, 3. sér. **3,** 291–331; and Journ. de Santé, Paris, 1902, **19,** pt. 2, 81.

—— Description anatomique d'un renard marin [*Alopecias vulpes*]. 1671–1757. 8 p. 2 pls. Pre-Linn. 1671.1

This paper contains what was long thought to be the earliest known figure and description of the spiral valve of a shark. An earlier is noted under Steno, N. 1664.1 & 2, this section. Perrault's paper has been published at least 15 times. Nine of these issues have entirely different sources of publication and are listed herein.

I. Mémoires pour servir à l'histoire naturelle des animaux. Paris, 1671–76. xii, 207 p. 31 pls. fol.

Other eds. bearing this title are, Paris, 1688, 1700; La Haye, 1731; Amsterdam, 1736, 1758.

II. Essais de physique. 3 vols. Paris, 1680. 8°.

Renard marin, vol. III, p. 218.
Another ed., 4 vols. Paris, 1688.

III. Description anatomique de divers animaux disséqués dans l'académie royale des sciences, etc. Paris, 1682. 4°.

The 1st ed. bearing this title is not known. An English version is:

IV. Memoirs for a natural history of animals. Containing the anatomical descriptions of several creatures dissected by the Royal Academy of Sciences at Paris. London, 1688. 4°.

Reissued, London, 1701, according to the catalogue of the British Museum (Natural History); 1702, according to Engelmann.

V. In Valentini, M. B. Amphitheatrum Zootomicum, 1720, pt. II, 82–84. pl. 65.

VI. Oeuvres diverses de physique et de méchanique. 2 vols. Leyden, 1721. 4°.

Alopecias vulpes, vol. II, p. 439.

VII. Mémoires de l'académie royale des sciences depuis 1666 jusqu'à 1699. Paris, 1733, **3,** 117–124. 2 pls.

For notes on this revised ed. of Perrault's paper, *see* the three unnumbered pages following p. xx in this volume (**3**) cited.
German versions follow.

VIII. Zur natürliche Historie der Thiere dienliche Nachrichten. Nürnberg, 1753. 4°.

IX. Abhandlungen zur Naturgeschichte der Thiere und der Pflanzen. Nürnberg, 1757. gr. 4°.

Contains additional papers by Charas and Dodart.
For anonymous accounts of the dissection of this shark, *see* Anon. 743 & 769 (1667).
For a modern reprint of this much published memoir, *see* Perrault, 1866.1.

—— Observation sur l'epée qui est au milieu du museau de poisson nommé espadon, dont les points ne sont pas adhérentes à la partie osseuse. Mém. Acad. Sci. Paris, 1686–1699 (1733), **2,** hist., 48. Pre-Linn. 1733.1

Perrault, a distinguished architect, designer and builder of the colonnade of the Louvre, was also a physician and anatomist of parts. One of the founders of the Paris Academy of Sciences, he was one of its most active early members.

Petit, *François Pourfour du. See* **Dupetit,** *F. P.*

Petiver, *James* [*c.* 1658–1718] For a notice of Petiver's life, *see* in Trimen & Dyer's "Flora of Middlesex." London, 1869. p. 379–385.

—— Musei Petiveriani centuriæ x. Animalia, plantas, fossilia ex variis mundi plagis advecta, ordine digesta, & nominibus propriis signata. London, 1695–1703. 96 p. 8°. Pre-Linn. 1695.1

Some British freshwater fishes described.

—— Gazophylaci naturæ et artis decades x, in quibus animalia quadrupedia, aves, pisces, reptilia, insecta, vegetabilia, corpora marina, etc. descriptionibus curtis et iconibus illustrantur. London, 1702–1706. 102 pls. fol. Pre-Linn. 1702.1

Some British and foreign fishes described.

—— An account of animals and shells sent from Carolina to Mr. James Petiver, F. R. S. Phil. Trans. Roy. Soc., 1706, **24,** 1952–1960. Pre-Linn. 1706.1

Various forms of Glossopetras, p. 1960.

—— De piscibus fluviatilibus Anglicanis; an account of our freshwater

fishes, viz., such as are found in lakes, meres, pools, ponds, or rivers. Mem. for the Curious, 1708, 127–134.
Pre-Linn. 1708.1

—— Pteri-graphia Americana, icones continens, etc., cui adjiciuntur crustacea, testacea, aliaque animalia fere omnia ex insulis nostris Charibbæis. London, 1712. 20 pls. fol.
Pre-Linn. 1712.1

Some American fishes figured & described.
Petiver's original works, as and when published, were collected and bound together and issued under covering titles in two editions as follows:

Opera omnia ad historiam naturalem spectantia; or, Gazophilacium, containing several thousand figures of birds, beasts, plants, fishes, etc., with Latin and English names. 3 vols. London, 1764. fol. & 8°.
Figures of Brazilian fishes shown in pl. 68, etc.

Opera ad historiam naturalium spectantia; containing several thousand figures of birds, beasts, fishes, reptiles, insects, shells, corals and fossils, also of trees, shrubs, herbs, fruits, fungus, mosses, sea-weeds, etc., to which are now added 17 curious tracts. The additions corrected by James Empson. London, 1767. 2 vols. fol.

Peucer, *Caspar* [1525–1602] Appellationes quadrupedum, insectorum, . . . piscium . . . quas cum P. Ebero collegit. Lipsiæ, 1550. 8°.
Pre-Linn. 1550.1

This work passed through a number of eds.: Leipsic, 1559, & 1580; Wittenberg, 1551, 1556, 1558, 1563, & 1570.

Peucer, *C.*, & **Eber,** *P.* *See* **Eber & Peucer.**

Peyer, *Johannes Conrad* [1653–1712] De lepusculis, salmonum extis, intestino coeco, ventriculo anserino et renibus anserinis, etc. Ephemer. Acad. Nat. Cur., 1682 (1683), 2 dec., ann. 1, 199–205.
Pre-Linn. 1683.1

—— De rete mirabili. Ephemer. Acad. Nat. Cur., 1686 (1687), 2. dec., ann. 5, 355–358.
Pre-Linn. 1687.1

—— Anatomia anguillæ (In Muralt, J. de. Exercitationes medicæ, etc. Amsterdam, 1688, p. 383.)
Pre-Linn. 1688.1

See Muralt, J. de, in this section.

—— Descriptio anatomica salmonis (In Valentini, M. B. Amphitheatrum Zootomicum. Francofurti-a.-M., & Gissae, 1720, 2. pt. 120–121. pl.)
Pre-Linn. 1720.1

—— De salmonum sexu. (In his Parerga anatomica, VII, Lugduni, 1750.)
Pre-Linn. 1750.1

Pfeiffer, *Sigismund August.* Dissertatio piscem Jonæ deglutitorum fuisse balænam. Lubecæ, 1692. 4°.
Pre-Linn. 1692.1

—— Dissertatio apologetica piscem Ionæ deglutitorem fuisse balænam, opposita C. F. Paullini et J. H. Major aliisque Lamiæ propugnatoribus. Lübec, 1697. 3 pls. 4°. Pre-Linn. 1697.1

First title from Walbaum; second from Boehmer. Probably the same article.

Phile *or* **Philetes,** *Manuel* [1275–1345] De animalium proprietate. Venice, 1533. Pre-Linn. 1533.1

Contains reference to some 15 fishes, mainly excerpted from Aelian.
1st ed. & in Greek. Other eds.: Leipsic, 1575; Heidelberg, 1596; Utrecht, 1730. The best ed., (copy, N. Y. P.), is:

—— De proprietate animalium, edidit Corneille de Pauw. Utrecht, 1730. 4°. Pre-Linn. 1730.1

Best available in F. Lehrs & F. Dübner, "Poetæ bucolicii et didactice" (Didot series. Paris, 1846).

Philo, ——. Philonis chronographi, arca templorum referata: ut & trinum marinum. Augspurg, 1693. fol.
Pre-Linn. 1693.1

"Pisces aliquot Ponti Euxini, Propontidis & Archipelagi continet."
Not seen; title and comment from Artedi.

Picinelli, *D. Filippo.* Mondo simbolico formato d'imprese scelte, spiegate, ed' illustrate. Venetia, 1670. pls. fol. Pre-Linn. 1670.1

First edition of this encyclopaedia, whose author was canon of the Lateran in Rome. The Latin version which follows was made by Augustinus Erath, a professor in the royal college of Wettenhausen.

—— Mundus symbolicus, in emblematum universitate formatus, explicatus, et tam sacris quam profanis eruditionibus ac sententiis illustratus; etc. 2 vols. [in 1]. Coloniæ Agrippinæ [Cologne], 1681. 738; 276 p.
Pre-Linn. 1681.1

Fishes, vol. I, book VI, p. 432–475.
Copy, A. M. N. H. Other eds.: Cologne, 1687, 1694, 1715.

Picolo, *Francisco Maria.* An extract of a memoir concerning the discovery of a passage by land to California with a map and description of that country . . . printed at Paris, [1702]. Phil. Trans. Roy. Soc., 1708, **25,** 232–240.
Pre-Linn. 1708.1

Mentions sea fishes of California observed by the Jesuits in 1697.

Pictorius, *Georgius* [*fl.* 1540] Medicinæ tam simplices quam compositæ

Pictorius, *G.* ad omnes ferme corporis humani adfectus ex Hipp. Gal. Avic. Aegineta et aliis ordine alphabetico conscriptæ . . . Accessit . . . leporarium, quorundam animalium quadrupedum et avicularum continens naturas ac proprietates, rem medicam concernentes. Accedit Constantini Africani quoque de animalibus elegantissimus liber: et Lippii Collesis, Oppiani poetæ Halieuticon, sive de piscibus tractatus, etc. Basiliæ, 1560. 57 p. 16°. Pre-Linn. 1560.1

—— PANTOPOLION, continens omnium ferme animalium, plantarum et metallorum naturas, carmine elegiaco, item de avium, piscium, serpentum, radicum, herbarum, seminum, fructuum, aromatum, metallorum & gemmarum natura, item de apibus, cera, melle, & aliis. Basiliæ, 1563. 8°. Pre-Linn. 1563.1

Piercandido Decembrio. *See* **Candidus,** *Decembrus Peter.*

Piers of Fulham. Vayne conseytes of folysche love undyr colour of fyscheing and fowlyng. [MS. *c.* 1420]. Pre-Linn. 1420.1

This work, written about 1420, contains the first known reference (a very short one) to angling in England. *See* Marston, R. B., 1894.1; also Westwood & Satchell, 1883.1.

First printed in Hartshorne's "Ancient metrical tales," 1829, from a MS. in the library of Trinity College, Cambridge; and again by Blakey in his "Historical sketches," 1856. However, it is most available in "Remains of the early popular poetry of England; collected and edited by W. C. Hazlitt." London, 1856. vol. II, p. 1–15.

Pietre, *Nic.,* & **Guenault,** *Fr.* Ergo pisces saxatiles euchymi. Paris, 1614. Pre-Linn. 1614.1

Title from Boehmer.

Pisides, *George* (*Bishop of Constantinople*) [7th cent.] Hexæmeron [Greek and Latin]. Geneva, 1614. fol. Pre-Linn. 1614.1

A poem dealing with the 6 days of creation. The Greek MS. is in Vienna Library.

Piso, *Guilielmus* (*Willem*) [1611–1678] De medicina Brasiliensi libri quatuor: I. De aëre, aquis, & locis. II. De moribus endemiis. III. De venenatis & antidotis. IV. De facultatibus simplicium. [Edited by Johann de Laet, and published as section I. of "Historia naturalis Brasiliæ."] Lugduni Batavorum, & Amstelodami, 1648. 122 p. figs. Pre-Linn. 1648.1

Pisces venenati, p. 44–45, with a figure of a poison toad-fish, called the "Niqui."

—— De Indiæ utriusque de naturali et medica libri quatuordecim . . . Amstelædami, 1658. 13 leaves, 327 p.; 3 leaves, 39 p.; 226 p. ills. fol. Pre-Linn. 1658.1

"The first part of this folio bears title as follows: 'Historiæ naturalis et medicæ Indiæ Occidentalis,' and consists of Marcgrave's 'Natural History of Brazil' and Piso's 'Medicinal Plants of Brazil' interwoven to form five books . . . It covers 327 pages. Next comes Marcgrave's 'Tractatus Topographicus,' etc., 39 pages in length. Next, he incorporates Jacob Bondt's 'Historiæ naturalis et medicæ Indiæ Orientalis,' 160 pages, and concludes with his own 'Mantissa Aromatica,' 66 pages." — Gudger in Pop. Sci. Monthly, 1912, **80**, 265.

Fishes, p. 47–74; 293–301.

Regarding Piso's alleged plagiarism from Marcgrave, Cuvier and Valenciennes speak as follows: "On ne voit pas comment quelques écrivains ont pu accuser Pison d'être plagiare de Margrave; il lui rend, au contraire, partout justice dans ses deux éditions."

For a full discussion of the question of the relations between Piso and Marcgrave, and of the matter of plagiarism, *see* the article by Gudger referred to. *See* also note under Marcgrave, this section.

Plancus, *Janus* (**Bianchi,** *Giov.*) [1693–1775] Epistola de mola pisce [Ostracion] ad Josephum Martium Bononiensum. Arimini, 1741. fig. 4°. — Comm. Instit. Bonon., 1746, **2,** 297–303; *Ibid.,* 1755, **3,** 331–334. pl. — Hamburg. Mag., 1757, **18,** 3–8. — Allg. Mag., —— **9,** 247. — Comm. Lips., —— **5,** 306. Pre-Linn. 1741.1

Comments on absence of pancreas.

Platearius, *Johannes* (*Medicus Salernitanus*) Expositio in Nicolai Myrepsi antidotarium. Venetiis, 1558. fol. Pre-Linn. 1558.1

"On trouve, dans cet ancien ouvrage, quelques détails peu importans sur un fort petit nombre de poissons." — Cloquet.

A very popular work in Italy. Nine other eds.: Venice; 1490–1602.

Platt, (*Sir*) *Hugh* [1552–*c.*1611] For a notice of Sir Hugh Platt and his "Jewell House," *see* Bigby's "Visions of the times of old," vol. I, p. 220.

—— The jewell house of art and nature, etc. London, 1594. 232 p. 4°. Pre-Linn. 1594.1

Fishing methods and various recipes for catching fish.

Other eds.: London, 1613, 1653, 1673. Copy 1st ed., N. Y. P.

Pliny (*Secundus*), *Caius* [23 B. C.–79 A. D.] For a memoir, *see* Crichton, Andrew, in Jardine's Naturalist's Library (Selby's Natural History of Pigeons), vol. IX, 1835; 2nd issue, 1845–46. For commentaries on Pliny's work, *see* Barbarus, H. 1778.1; Steier, A. 1912.1, 1913.1, 1913.2, Add. 1913.1. For an extended list of editions, translations, and commentaries, *see* Boehmer, G. R. "Bibliotheca Scriptorum Historiæ Naturalis." Leipsic, 1785, vol. I, pt. I, p. 186–211.

—— Naturalis historiæ. Venice, 1469. fol. Pre-Linn. 1469.1

Published by John Spira. Unpaged, but containing 355 leaves with 50 lines to a full page.

Boehmer lists a doubtful ed. of 1461 at Venice, and quotes Haller as authority for an ed. of 1468 at Verona. It is generally accepted, however, that the above ed. (of which a copy is in the British Museum [Natural History]) is the *editio princeps*.

This, the most popular natural history ever published, as a whole or in separate books passed through a multitude of eds. *ante* 1758. There were 3 issued in 1470 and at least 2 each in 1472 and 1473. There were 23 eds. issued prior to 1492 and 31 prior to 1500, all in folio, and all published in northern Italy. At least 68 eds. were issued in the 16th century, and 27 in the 17th.

Early eds. in languages other than Latin are: Italian, Rome, 1473; Venice, 1476 (Florentine version); Venice, 1481: first German version, Frankfort, 1511. The earliest French version known to us is Lyons, 1562. fol., Du Pinet translator; the first English, London, 1585; the earliest Spanish, 1599; Dutch, Amsterdam, 1610.

The first illustrated ed., according to Walbaum, was the Venice folio of 1470, 1471 or 1472, published by N. Jenson (the figs. said to have been colored); according to Boehmer, the best illustrated ed. was Venice, 1513 (figs. by Alex. Benedict); and the next the Italian version, Venice, 1535.

The only titles available for any of the above are:

—— Bücher und Schriften von Natur, Art, und Eigenschaft aller Creaturen. Frankfort, 1511. fol. Pre-Linn. 1511.1

Reprinted, 1584, 2 vols. fol.

—— The secrets and wonders of the worlde, a booke right rare and strange, containing many excellent properties given to man, beastes, fowles, fishes, serpents, trees, and plants, translated out of Frenche. London, 1585. 4°. (blk. letter.) Pre-Linn. 1585.1

This is possibly a paraphrase rather than an exact translation. Better known is the famous edition of 1601.

—— Plinies natural historie of the world, translated into English by Philemon Holland, Doctor of Physick. 2 vols. London, 1601. Pre-Linn. 1601.1

2nd ed., London, 1635.

—— Libro nono de Cayo Plinio Segundo de la Historia Natural de los pescados del mar, de lagos, estanques y rios. Dirijida al rey Don Felipe III, Rey de España é Indias. Madrid, 1603. 4°. Pre-Linn. 1603.1

—— Plinius van menschen, beesten, vogeln und visschen. Arnheim, 1610. 4°. Pre-Linn. 1610.1

This is probably an incomplete version; a fuller one is:

—— Des wijdt-vermaerden natuurkondigers viif boecken, handelende van de nature . . . V: van de visschen, oesters, kreeften, enz. Amsterdam, 1657. figs. 8°. Pre-Linn. 1657.1

Other famous Pre-Linnæan eds. are those of Paris, 1526 & 1543; Basel, 1539 & 1549; Leyden, 1561, 1582, & 1587. Others might be named, but the best of the early eds. is that issued at Leipsic in 1778 in Latin, in 8 vols. 8°, under the general editorship of J. G. F. Frantzius with the cooperation of Harduin, Barbarus, Pintani, Rhenani, Galenius, Dalechamp, Scaliger, Vossius, Gronow, and others.

The best modern French and English versions follow:

Histoire naturelle; traduction nouvelle par M. Ajasson de Grandsagne, annotée par M. M. Beudant, Brogniart, Cuvier, Daunou, etc. 20 vols. Paris, 1829–33. 8°.

A later French translation is that by M. Littré. 2 vols. Paris, 1848–50. 8°.

The natural history of Pliny. Translated with . . . notes and illustrations by . . . J. Bostock and H. T. Riley. 6 vols. London, 1855–57. 8°.

The natural history of fishes, vol. II, book IX, p. 358–475.

Copies of early eds. of Pliny in the U. S. are: 1469, Prin.; 1472, L. C., J. C., H., N. Y. P., Y., H. E. H.; 1479, S. C.; 1534, A. M. N. H.

Plot, *Robert* [1640–1696] For a sketch of Plot's life, *see* in Wood, Anth. a. "Athenæ Oxoniensis," etc. 4 vols. London, 1813–20; also in the 1705 edition of his works below.

—— The natural history of Oxfordshire, being an essay toward the natural history of England. Oxford, 1677. 15 pls. fol. Pre-Linn. 1677.1

Fishes, p. 183–186; 205–210.

Reviewed in Phil. Trans. Roy. Soc., 1686–87 (1688), **16**, 207–213.

—— Natural history of Staffordshire. Oxford, 1686. 449 p. pls. fol. Pre-Linn. 1686.1

Fishes (migration of eels, etc.), p. 240–246.

—— The natural history of Oxfordshire. Second ed., with large additions and corrections. Oxford, 1705. x, 366 p. 16 pls. map. Pre-Linn. 1705.1

Fishes, p. 179–195.

Lowndes notes an ed., 1710; but Agassiz gives dates as 1676, 1686, & 1705.

Pluche, *Natalis* (*Noel Antoine*) [1688–1761] For his life, *see* in Gaz. Litt. Europe, February, 1765.

—— Le spectacle de la nature, ou entretiens sur les particularités d'his-

Pluche, *N.*
toire naturelle, qui ont paru les plus propres à rendre les jeunes gens curieux, et à leur former l'esprit. Paris, 1732–51, 8 vols., 192 pls. Pre-Linn. 1732.1

Fishes and fishing in vols. I & II.
The 1st ed. of one of the most popular natural history books ever written. Either as a whole or in parts, it passed through a great number of editions and translations. At least 42 are known, distributed as follows: French, 23; English, 7; German, 6; Italian, 4; Spanish and Dutch, 1 each. Of the 23 French eds., 8 were issued, Paris, 1732–1764; the 15 others at 8 cities scattered over France, 1733–1859.
Pluche's work was still being printed in France in the 19th century. Four eds. were issued at Tours, 1851–1859, for church schools.
Foreign versions are:

—— Spectacle de la nature; or nature display'd, being discourses of such particulars of natural history as were thought most proper to excite the curiosity, and form the minds of youth. 9 vols. London, 1736–48. 200 pls. 8°. Pre-Linn. 1736.1

2nd English edition. First, 1735; 7 others, 1739–1786, London.

—— Schouwtoneel der natuur, of samenspraaken over de byzonderheden der natuurlyke historie, etc. 10 deelen. s' Gravenhaage & Amsterdam, 1737–48. pls. 8° Pre-Linn. 1737.1

The one Dutch version.

—— Spettacolo della natura, esposto in vari diologhi. 14 vols. Venezia, 1745. 12°. Pre-Linn. 1745.1

3rd Italian ed.: others, Venice, 1737, 1740, 1752.

—— Schauplatz der Natur, oder Unterredungen von der Beschaffenheit und den Absichten der natürlichen Dinge. 8 parts. Nürnberg, 1746–70. pls. 8°. Pre-Linn. 1746.1

1st German version (of 1732 ed.); 6 others, 1746–1792.

Plumier, *Charles* [1646–1704] Zoographia americana, pisces et volatilia continens, auctore R. P. C. Plumier. [*c.* 1695] Pre-Linn. 1695.1

i. Poissons, oiseaux, lézards et insectes — 157 figures of fishes.
ii. Poissons d'Amérique — 100 figures of fishes.
iii. Poissons et coquilles — 80 figures of fishes.
These comprise 3 vols. of unpublished drawings of Martinique fishes, composed of 169 folio pages, preserved in the Bibliothèque Nationale, at Paris. Cuvier & Valenciennes state that these were once in the possession of M. E. Bloch, who refers to them in the preface of his Ichthyology. Many of these figures were reproduced by Bloch and Lacépède. For further data, *see* Biog. Univ., t. XXXV, p. 95.

Plutarch [*c.* 46–120 A. D.] De industria animalium, utrum terrestria an aquatica plus sapiant. Græce et Latine, Sim. Grynæo interprete. Basel, 1534. 8°. Pre-Linn. 1534.1

French ed., translated by A. P. de la Rochefoucault, Paris, 1557.

—— Les oeuvres de Plutarque, qui sont les vies des hommes illustres & les oeuvres morales. 13 vols. Paris, 1574. 8°. Pre-Linn. 1574.1

The *editio princeps*, by H. Stephanus, appeared in 1572. Numerous other early eds. were issued.
The works of Plutarch, outside of the "Lives," are included under the group term "Morals" (Moralia). In later editions of the works the first item above is included in this group. The earliest English translations of the "Morals" are:

—— Plutarch's Morals, translated into English by Philemon Holland, Doctor in Physicke. London, 1603. fol. Pre-Linn. 1603.1

—— Plutarch's Morals translated from the Greek by several hands. 5 vols. London, 1684–94. sm. 8°. Pre-Linn. 1684.1

Reprinted, London, 1718. Abridged eds. were issued London, 1704 & 1707.
For present day English readers the "Morals" are best available in the Bohn ed. of 1882–88 (a revision of the 1684 version) and for Americans in the revision of the 1684 version by W. W. Goodwin, Boston, 1870.
Vol. III, book II, question 7 of the Symposiacs — "About the fish called Remora or Echeneis [as a shipholder]." Vol. V, p. 157–217, "Which are the more crafty, water animals or those creatures that breed on land"; p. 195–208, "Sagacity of fishes."

Pollux, *Julius* (*Grammaticus*) [*fl.* 2nd cent. A. D.] Onomasticon decem libri constans; adjecta interpretatio Latina, etc. 2 parts [in 1 vol.] Francofurti, 1608. 4°. Pre-Linn. 1608.1

—— Onomasticon Græce et Latine, etc. Amstælodami, 1706. fol. Pre-Linn. 1706.1

Pollux, a Greek writer towards the close of the second century of our era, in one of the books of his "Onomasticon" tells us a good deal about fish and fishing. His book is a dictionary arranged according to subject matter.
Modern eds. in Greek are those by W. Dindorf, 1824, and I. Bekker, 1846.

Polo, *Marco* [*c.* 1254–1324] For a brief sketch of the travels of Marco Polo, a critical discussion of the various early editions of his book, and an excellent translation, *see* Marsden, William. "The travels of Marco Polo, a Venetian, in the 13th century," etc. London, 1818. roy. 8°. *See* also the article in Encyclopædia Britannica, vol. XXII, 1911, by Sir Henry Yule and C. R. Beazley.

—— De le meravegliose cose del mondo. Venice, 1496. 8°.
Pre-Linn. 1496.1

The 1st Italian ed. Other imperfect or preliminary Italian eds. are known. The *editio princeps* (in Latin) was printed at Basel or Venice between the years 1484 and 1490.

Copies 1496 ed., B. A.; 1496 & 1500 eds., H. E. H.

Of the large number of editions and versions issued *ante* 1758, only 2 others will be listed here. For others, *see* Marsden (work cited).

—— Marci Pauli Veneti de regionibus orientalibus libri III. Basel & Paris, 1532. Pre-Linn. 1532.1

—— The most noble and famous travels of Marcus Paulus . . . in the East partes of the world, etc. London, 1579. Pre-Linn. 1579.1

1st English version. A modern one is:

The book of Marco Polo . . . concerning the kingdoms and marvels of the East. Newly translated & edited, with notes by Col. H. Yule. 2 vols. London, 1871.

This edition, revised and augmented by Henri Cordier, was republished, London, 1903. This latter is the greatest thesaurus of Polo learning to be found in any language.

This old traveller refers to fishing and fish eating by the various peoples among whom he travelled.

Polyhistor. *See* **Solinus,** *C. J.*

Pomet, *Pierre* [1658–1699] Histoire générale des drogues, traitant des plantes, des animaux, & des minéraux; ouvrage enrichy de plus de quatre cent figures en taille-douce tirées d'après nature; etc. Paris, 1694. pt. I, 304; pt. II, 108; pt. III, 116 p. fol.
Pre-Linn. 1694.1

First ed. of an esteemed work which was reprinted in 1735. An English translation first appeared in 1712, and one in German in 1717. The 3rd English edition is:

—— A compleat history of druggs, written in French by Monsieur Pomet. London, 1737. 419 p. ills. 4°.
Pre-Linn. 1737.1

Ichthyocolla (fish glue), p. 285–286; fishes, 292–298. figs.

Pond, *Arthur* [1705–1758] Letter to the Right Honorable George, Earl of Macclesfield . . . concerning the stones mentioned [by F. Byam]. Phil. Trans. Roy. Soc., 1755 (1756), **49,** 297–298. pl. Pre-Linn. 1756.1

See Byam, F. 1756.1, in this section.

Pontoppidan, *Erik* (*Bishop of Bergen*) [1698–1764] For a sketch of his life and an estimate of his works, *see* article by Gjellerup, S. M., in Danske Biographisk Lexikon, 1899. vol. XIII.

—— Det förste forsög paa Norges natuurlige historie forestillende dette kongeriges luft, grund, fielde, vande, växter, metaller, mineralier, steenarter, dyr, etc. 2 Deele. Kjøbenhavn, 1752–53. 30 pls. 4°. Pre-Linn. 1752.1

The 2nd ed.; the first Danish ed., Hafniæ, 1752. This work by some bibliographers is dated 1751–53, by others, 1752–54. Another ed. appeared in 1754. German and English versions are:

—— Versuch einer natürlichen Historie von Norwegen, worinnen die Luft, Grund und Boden, Gewässer, Metalle, Mineralien, Steinarten, Thiere, Vögel, Fische und endlich das Naturel, wie auch die Gewohnheiten und Lebensarten der Einwohner dieser Königreichs beschrieben werden. 2 vols. Kopenhagen, 1753–54. 367 & 536 p. 16 & 14 pls. 8°. Pre-Linn. 1753.1

—— The natural history of Norway, containing the soils, waters, minerals, beasts, birds, fishes, &c. London, 1755. fol. Pre-Linn. 1755.1

Has a chapter on the sea-serpent, and an illustration of it on p. 196.

For other works by Pontoppidan, *see* in vol. II, and Addendum.

Post, *Franz* [1614–1680] Theatrum rerum naturalium Brasiliæ, (Libri Picturati A 32–35). [*c.* 1643]
Pre-Linn. 1643.1

This collection of oil paintings of the plants and animals of Brazil, made by Franz Post in Brazil, brought back to Germany by Count Maurice of Nassau, collected and bound with an illuminated title page by Dr. C. Mentzel, is preserved in the great library of Berlin. For the history of these paintings, *see* Gudger, E. W. Add. 1912.1 (p. 268–272), and Mentzel, C., this section.

Preston, *Charles.* A general idea of the structure of the internal parts of fish. Phil. Trans. Roy. Soc., 1697 (1698), **19,** 419–424. Pre-Linn. 1698.1

Prévost, *Antoine François* [1697–1763] Histoire générale de voyages; ou, nouvelle collection de toutes les relations de voyages par mer et par terre. Nouvelle édition. 25 vols. La Haye, 1747. pls. maps. Pre-Linn. 1747.1

Différentes espèces de poissons d'Afrique, I, p. 317; V, p. 70, 348; VI, p. 413, 528; du Sierra Leona, IV, p. 235; de la Chine, VIII, p. 390. L'Ouwa ou l'oiseau Pescheur, pêche chinoise, VIII, p. 106. Poissons du Groenland, XXV, p. 258–262. Poissons extra-ordinaires d'Amboine, XVII, p. 84–254. 485 figs. Pêche des morues, XXI, p. 517, 520; XXIII, p. 351; XXV, p. 259. Poissons des mers du Nord, XXII, p. 388–410; XXV, p. 266.

Title and notes from Bosgoed.

The 1st ed. Others are: English, London (4 vols.), 1745–47 (probably an abbreviated version); French, Paris, (15 vols.), 1746–59; Dutch, The Hague (11 vols.), 1747–50 & Amsterdam

Prévost, *A. F.*
(21 vols.), 1755–67; German, Leipzig (21 vols.), 1747–74; Spanish, Madrid (28 vols.), 1763–71.
Not seen, and not known whether the versions contain all the data of the 1st ed. This probable save in case of the English ed. noted.

Preyel *or* **Preyelius,** *Adam.* Artificia hominum ad miranda naturæ in Sinâ et Europâ, etc. Francofurti, 1655. 12°. Pre-Linn. 1655.1

42 species of Chinese and European fishes are described.
This title is commonly cited as anonymous, but Gronow (p. 12), on the authority of Voigt, credits it as above.

Prueckmannus, *Fredericus. See* **Bruckmann,** *Fredericus.*

Purchas, *Samuel* [*c.*1577–1626] Purchas his pilgrimage; or relations of the world . . . from the creation unto this present; in foure parts . . . etc. London, 1613. 4°. Pre-Linn. 1613.1

This is the 1st ed. The 2nd, 1614; 3rd, 1617. Next comes:

—— Purchas his pilgrim, etc. London, 1619. Pre-Linn. 1619.1

This was followed by Purchas's *magnum opus:*

—— Hakluytus posthumus, or Purchas his pilgrimes. Contayning a history of the world in sea-voyages and lande-travells by Englishmen and others. 4 parts. London, 1625–26. fol. Pre-Linn. 1625.1

Notes on fishes scattered throughout.
Dutch version, Amsterdam, 1655. The only modern reprint was issued at Glasgow, 1905–07 in English.

Pyrard de Laval, *François.* Voyage F. P. de Laval contenant sa navigation aux Indes Orientales, Maldives, Moluques, & au Brésil, etc. Paris, 1579. Pre-Linn. 1579.1

Fishes and fishing, p. 6–8, 88, 136–141.
Other eds.: 1611, 1619. Available for English present-day readers as:

The voyage of F. Pyrard of Laval to the East Indies. 2 vols. Hakluyt Soc., Works, 1887–90, no. 76, 77, 80. 8°.

Q

Quercu, *Leodegarius à,* pseudonym for **Duchesne,** *Léger* [–1588] In Ruellium de stirpibus epitome. Cui accesserunt volatilium, gressilium, piscium, & placentarum, magis frequentium apud Gallias nomina. Parisiis, 1539. 24 p. 12°. Pre-Linn. 1539.1

This work formed the basis of E. Estienne's "De Latinis et Græcis nominibus arborum," &c.
Another ed., with slightly different title is:

—— In Johannem Ruellium de stirpibus latino-gallica epitome, item volatilium, gressilium, piscium, & plantarum apud Gallos magis frequentium nomina. Rothomagi [Rouen], 1539. 8°. Pre-Linn. 1539.2

Other eds.: Paris, 1543 & 1544; Cadomi, 1549.

R

Rabanus, *Maurus* [*c.* 776–856] For brief sketch of Rabanus, and for a list of biographies and commentaries on his writings, *see* under his name in the Catholic Encyclopedia, 1911, vol. XII.

—— De universo [Coloniæ Agrippinæ, 1617] Pre-Linn. 1617.1

Fishes, book VIII, chap. 5.

The "De Universo" is, in arrangement and method, a forerunner of the "Speculum" of Vincent de Beauvais. The date of the first printing is not certainly known, but there was an edition of Rabanus's collected works issued in 1617 or 1627, which has been reprinted and is available in Migne, J. P. "Patrologiæ cursus complectus . . . series secunda, doctores scriptoresque ecclesiæ Latinæ, Tomus V, vol. 5," "De Universo," cols. 9–614. Paris, 1852.

Raimondi, *Eugenio.* Le caccie delle fiere armate e disarmate e degl' animale quadrupedi, volatili e acquatici. Brescia, 1621. xvi, 410 p. 4°. Pre-Linn. 1610.1

The 4th book treats of fishes in 211 chapters. Other eds.: Napoli, 1626; Venetia, 1785.

Ramus, *Jonas.* Norriges bescrivelse. Kiopenhagen, 1715. 4°. Pre-Linn. 1715.1

With a catalogue of fishes and other animals and plants appended.

Ramusio, *Giovanni Battista* [1485–1557] For a brief sketch of his life and an exposition of his writings, *see* article by Sir Henry Yule in Encyclopædia Britannica, 11. ed., 1911, vol. XX, 882–884.

—— Terzo volume delle navigatione et viaggi raccolto gia da M. Gio. Battista Ramusio nel quale si contengono . . . Si come si legge nelle diverse relationi, tradotte dal Ramusio di lingua Spagnuola & Francese nella nostra, & raccolte in questo volume. Venetia, 1565. 456 p. cuts. maps. fol. Pre-Linn. 1565.1

—— Della historia dell' Indie. Venetia, 1606. Pre Linn. 1606.1

This contains some descriptions of West Indian fishes, and an account of fishing with the remora.

Ramusio's collection of "Navigationi e Viaggi" was one of the first and is still one of the most valuable of its kind. Issued separately in 3 volumes and in numerous editions, it is difficult to avoid confusion in setting the dates for these. However, since the 3rd volume is devoted exclusively to voyages to the new world, it is of particular interest here and it only has been listed. It appeared in three editions, 1556, 1565, and last (and much augmented) 1606.

Rappolt, *Carl Henr.* Vom Abzuge der Heringe aus Preussen. Königsberg. Intelligenzwerke, 1739, no. 33. — Erläuterten Preussen, pt. 5. Pre-Linn. 1739.1

Rasarius, *Joannes Baptista* [1517–1578] Xenocratis de alimento ex aquatilibus animantium libellus, Græce nunc primum editus, imperfectus. Idem Latine perfectior, J. B. Rasario . . . interprete, &c. (In Dubravius, J. De Piscibus . . . libri quinque, &c. Zurich, 1559. 8°.) Pre-Linn. 1559.1

Rath, *D. Hier.* (*præses*) Disputatio de iure venandi, aucupandi et piscandi. (In Mor de Nigromonte, G. Pre-Linn. 1602.1., p. 128–144.) Pre-Linn. 1602.1

Jo. Ge. Haydenpuecher, *respond.*

Ray, *John* [1628–1705] For life and letters, edited by E. Lankester, *see* "Memorials of John Ray" (a republication with biological and critical notes by J. E. Smith, Cuvier, & Dupetit-Thouars, of "Select remains of . . . J. Ray, . . . with his life by W. Derham," London, 1760), and "The Correspondence of John Ray": found under Ray, J., 1846.1, & 1848.1. *See* also "Philosophical letters," 1718, below. For another memoir, *see* that by Jas. Duncan in Jardine's "Naturalists' Library," 1835 ed., vol. VIII; 1845–46 ed., vol. XXXIII; also in his (Duncan's) "Entomology," 1845–46, vol. VI. Also Boulger, George Simonds, "The life and work of John Ray, and their relation to the progress of science." Trans. Essex Field Club, 1885 (1886), **4,** 171–188.

—— Observations topographical, moral, & physiological made in a journey through part of the Low-Countries, Germany, Italy, and France, etc. London, 1673. xiii, 499, 115 p. 4 pls. ills. 8°. Pre-Linn. 1673.1

Contains brief mention of glossopetras p. 116–117, and of swordfish fishing, p. 316.

Ray, *J.*
Other eds. are: 1678, 1693, 1738, 1746, 1758. The 1738 ed. consists of two volumes. The first is a reprint of the preceding work with a slightly changed title; the second is a "Collection of Curious Travels," of no interest here save that it contains the travels in Greece of Alpinus. (*q. v.*) This "Collection" was first printed separately, London, 1693.

—— A collection of English words not generally used, . . . in two alphabetical catalogues; with catalogues of English birds and fishes, etc. London, 1674. 178 p. 16°. Pre-Linn. 1674.1

Contains a catalogue of fresh-water fishes found in England.
A second ed., enlarged, 1691. Said to have been republished in Ray's "Proverbs," 4th ed., 1768, the first ed. of which seems to have appeared in 1670.

—— A letter written to the publisher by the learned Mr. Ray, containing some considerations on the conjecture in numb. 114, of these tracts, about the swimming bladders in fishes. Phil. Trans. Roy. Soc. 1675, **10**, 349–351. Pre-Linn. 1675.1

Erroneously ascribed by Gronow and others to Robert Boyle, and listed under his name because the "conjecture in numb. 114" was "illustrated by an experiment of Mr. Boyle's."

—— F. Willughbeii . . . de historia piscium libri quatuor . . . Totum opus recognovit . . . librum etiam primum & secundum integras adjecit J. Raius. Oxonii, 1686. v, 343, 30, 13 p. 188 pls. Pre-Linn. 1686.1

This great work of his pupil Willughby, left in MS. at his death, was edited and published by Ray, to whom much of the credit is due.
2nd ed., London, 1743. fol. *See* also Willughby, F., this section.

—— De lingua piscium . . . de piscibus in genere, etc. [in] Appendix ad historiam naturalem piscium (In Willughby, F. De historia piscium. Oxonii, 1686) p. 8–13. Pre-Linn. 1686.2

—— The wisdom of God manifested in the works of the creation, etc. London, 1691. 8°. Pre-Linn. 1691.1

Air-bladders of fishes an adaptation to their environment.
This work passed through many eds. (the 12th, 1759) and translations: French, Utrecht, 1714; German, Goslar, 1718, Leipsic, 1732; Dutch, Amsterdam, 1732, 1768.

—— Synopsis methodica avium & piscium; opus posthumum: quod vivus recensuit & perfecit ipse auctor, in quo multas species in ipsius ornithologia & ichthyologia desideratas adjecit, methodumque suam piscium naturæ magis convenientem reddidit. Londini, 1710. pls. 8°. Pre-Linn. 1710.1

Later eds. are: 1713, 1721; & in Dutch, Amsterdam, 1769.

—— Philosophical letters between the learned Mr. Ray and several of the ingenious correspondents; to which are added those of Francis Willughby Esq. The whole consisting of many curious discoveries and improvements in the history of Quadrupeds, Birds, Fishes, Insects, Fossiles, Fountains, &c. London, 1718. 376 p. 8°. Pre-Linn. 1718.1

"Opus est posthumum a W. Derham in lucem editum, continens varia ad historiam naturalem & physicam spectantia." Title and comment from Gronovius.

Réaumur, *René Antoine Ferchault de* [1683–1757]. Observations sur la matière qui colore les perles fausses, etc., à l'occasion de quoi on essaie d'expliquer la formation des écailles des poissons. Mém. Acad. Sci. Paris, 1716 (1718), 229–244. Pre-Linn. 1718.1

The suggestion is here made for the first time that the concentric circuli of scales represent successive increments of scale growth.

—— Des effets que produit le poisson appelé en français torpille, ou tremble, sur ceux qui le touchent; et de la cause dont ils dépendent. Mém. Acad. Sci. Paris, 1714 (1741), 344–360.—Journ. Scav., 64, 620. 2 pls. Pre-Linn. 1741.1

—— Description d'un poisson d'une configuration monstrueuse. Mém. Acad. Sci. Paris, 1747, 52. Pre-Linn. 1747.1

—— Divers means for preserving from corruption dead birds, . . . quadrupeds, reptiles, fishes and insects. Phil. Trans. Roy. Soc. 1748 (1750), **45**, 304–320. Pre-Linn. 1750.1

Fishes considered, p. 319.
The original of this not found. Probably it is a translation of a French memoir sent direct to the Royal Society. This article has been reviewed or reprinted in abstract form many times. Boehmer (Vol. II, pt. I, p. 415) gives a list of 12, but most of them are obscure publications and probably are not to be found today.

Recchi, *Nardo Antonio* (*editor and commentator*). *See* **Hernandez,** *Francisco.*

Reck, *Mord. von der.* Disputatio juridica de piscatione. Solenniter defendendam suscepit M. von der Reck. Argentorati, 1662. 12 p. 4°. Pre-Linn. 1662.1

Redi, *Francesco* [1626–1698] For a life of Redi, *see* Salvini, A. S. in Opere, 1712–30, vol. I, pt. I. Also short notices in Locy, W. A. "Biology and its makers." 1908, p. 277; and Miall,

L. C. “The early naturalists.” 1912, p. 225.

—— Esperienze intorno a diverse cose naturali e particolarmente a quelle che ci sono portate dall’ Indie fatte da Francesco Redi e scritte in una lettera al Reverendissimo Padre Atanasio Chircher della Compagnia di Giesùæ. Firenze, 1671, 47–51. Pre-Linn. 1671.1

The same, another ed., 1686.

—— [Reference to his dissection of a Torpedo, “to see whether he could discover the seat and cause of its stupefactive [electric] power,” and remarks on the curious form of the iris in this species] (In a review of his “Esperienze intorno a diverse cose naturali, & particolarmente a quelle che ci son dall’ Indie.” Firenze, 1671. — Phil. Trans. Roy. Soc. 1673, **8**, 6003.) Pre-Linn. 1673.1

—— Osservazioni . . . intorno agli animali viventi che si trovano negli animali viventi. Firenze [Florence], 1684. iii, 253 p. 26 pls. 4°. Pre-Linn. 1684.1

Life history of eel.
Another ed., Naples, 1687; and in “Opere,” 1741, vol. I, no. 4. A Latin version is:

—— De animalculis vivis quæ in corporibus animalium viventium reperiuntur, observationes. Amsterdam, 1708. figs. 12°. Pre-Linn. 1708.1

These papers also found in “Opere”; Venice, 1687, 1712–30, 1742; Naples, 1740–41 (best ed. 7 vols. ills. 4°.)

Reisch, *Gregory* (*compiler*) [*c.* 1467–1503] For a biographical sketch, *see* Hartfelder in Zeitschr. Gesch. Oberrheins, Freiburg, 1880, n. F. **5**, 170–200. For bibliographical data about the various editions of Reisch’s work, *see* Sabin.

—— Margarita philosophica.. Heidelbergiæ, 1496. 4°. Pre-Linn. 1496.1

Some fishes are described.
This is a little library or “Circle of the Sciences” according to the theological ideas of the 15th century, in XII books, compiled by Gregory Reisch, prior of the Carthusian monastery near Fribourg.
First published in 1496, other eds. followed in quick succession: Fribourg, 1503 & 1504; Strasburg, 1504, 1508, 1512, & 1515; Basel, 1508, 1517, 1535 & 1583; & Venice, 1599. This last is the first and only version in a foreign tongue.
Copies, 1st ed., H., Col., A. G. S., N. Y. P. This last library has five other editions also.

Reiske, *Johannes* [1641–1701] De glossopetris Luneburgensibus ad virum nobilissimum & expertissimum Joh. Georgium Hieronymum epistolica consideratio. Lipsiæ, 1684. 56 p. **2 pls.** 4°. **Pre-Linn. 1684.1**

—— Commentatio physica æque ac historica de glossopetris Luneburgensibus. Norimberg, 1687. 84 p. pls. 8°. Pre-Linn. 1687.1

Renard, *Louis.* Poissons, écrevisses et crabes . . . que l’on trouve autour des isles Moluques, et sur les côtes des terres Australes . . . Ouvrage . . . qui contient un très grand nombre de poissons . . . de la mer des Indes: divisé en deux tomes, dont le premier a été copié sur les originaux de M. B. Coyett . . . Le second tome a été formé sur les recueils de M. A. Vander Stell . . . avec une courte description de chaque poisson . . . Donné au public par . . . L. Renard, &c. 2 vols. [in 1] Amsterdam, 1718–19. xviii, 100 col. pls. fol. Pre-Linn. 1718.1

The half-title reads: “Histoire naturelle des plus rares curiositez de la Mer des Indes.”
Contains crudely drawn and barbarously colored figures of 459 East Indian fishes. A few short and defective descriptions are found.
Another ed., or better reissue, Amsterdam, 1754. fol.
For a discussion of the authorship of this work, *see* Cuvier & Valenciennes, vol. I, p. 86–87. Also Ebert. Bibliog. Lexicon, 1821, vol. I, 789.
See also in this section: Coyett, B.; Fallours, S.; Van der Stell, A.; and Vlaming, C. de.

Rhanæus, *Samuel.* Von einigen merkwürdigen Fischen in Curland. Act. Breslav. Natur & Kunstgesch., 1725, Tentam 31, 175. Pre-Linn. 1725.1

“1) Von einem grossen Hechte. 2) Von andern grossen Fischen als Rehbsen, Steinbütten, Strömlingen. 3) Die berauschende Barsche. 4) Die unvermuthete Karpfen. 5) Die tödlichen Aale.”

Rhodius, *Jno.* [*c.* 1587–1659] Jecur lampetræ rubrum, itemque viride. (In his Mantissa anatomica, published in Bartholin, Thomas. Historiarum anatomicarum et medicorum. Copenhagen, 1661, vol. V, 15–16). Pre-Linn. 1661.1

Not seen; title from Cloquet.

Rhumelius, *Jo. Conr.* Philosophia animalis vivario, aviario, natatorio recessita carminice scripsit. Norimbergæ, 1630. 8°. Pre-Linn. 1630.1

Richardson, *Richard* [1663–1741] For data concerning this man and his works, *see* Turner, A. D., “Extracts from the literary and scientific correspondence [and a memoir] of R. Richardson.” 1835. 8°.

Richardson, *R.*

—— Several observations in natural history, made at North-Bierley in Yorkshire, . . . Communicated in a letter to Dr. Hans Sloane, R. S. Secr. Phil. Trans. Roy. Soc. 1714, **28**, 167–171. Pre-Linn. 1714.1

Observations on tench living for several days out of water; and on small size of trout and charr in mountain streams and lakes of Wales.

—— Part of a letter to Sir Hans Sloane concerning the *Squilla aquæ dulcis*. Phil. Trans. Roy. Soc., 1734, **38**, 331–332. Pre-Linn. 1734.1

Destruction of fish fry by an insect larva.

Richer, *Jean* [–1696] Observations astronomiques et physiques faites en l'isle de Caienne. Mém. Acad. Sci. Paris, 1666–1699 (1729), **7**, 233–326. Pre-Linn. 1729.1

Remarks on Gymnotus, p. 325.

Richter, *Ge. Gottlieb.* Progr. de piscium salutari cibo. Göttingen, 1752. 3 pl. 4°. Pre-Linn. 1752.1

Abstract in his Opusc. Medicin., vol. III, p. 216.

Richter, *Johann Gottfried Ohnefalsch.* Ichthyotheologie, oder: Vernunft- und schriftmässiger Versuch die Menschen aus Betrachtung der Fische zur Bewunderung, Ehrfurcht und Liebe ihres grossen, liebreichen und allein weisen Schöpfers zu führen. Leipzig, 1754. xxxii, 912, xxxii p. pls. 8°. Pre-Linn. 1754.1

25 freshwater fishes referred to in the Bible are described and common European names set for them.

A Dutch version is entitled:

Vischkundige onderwijser, in eene beschrijving der visschen, etc. Dordrecht, 1780. 319 p. 4°.

Riemer, *J. de.* Beschrijving van 's Gravenhage. Delft, 1730. 3 parts. pls. fol. Pre-Linn. 1730.1

Contains data about the fisheries and fishing industry at Scheveningen, pt. I, p. 50–59.

Rittershusius, *Conrad* [1560–1631] Catalogus doctorum virorum, qui præter Oppianum de venatione et piscatione, aut rebus ad eam pertinentibus scripserunt. (In his Prolegomena in Oppianum. Lugduni Batavorum, 1597, leaves 74 & 75). Pre-Linn. 1597.1

Rivière, *M.* Sur les dents pétrifiés de divers poissons comparées avec les dents des mêmes poissons nouvellement pêchés. Mém. Acad. Sci. Lettres Montpellier, 1708, **1**, 75–84. Pre-Linn. 1708.1

In German: Mineral. Belustig., **pt.** II, 283. — Vorräthe Auserlesener Aufsätze, **pt.** III, 737.

Rivinus, *Augustus Quirinus* [1652–1723] Observatio anatomica circa poros in piscium cute notandos. Acta Erudit. Lips., 1687, **6**, 160–162. Pre-Linn. 1687.1

Roberg, *Laurentius* (*præses*) Dissertatio medico-physica de piscibus . . . submittit alumnus regius . . . Upsaliæ, 1727. 26 p. figs. 12°. Pre-Linn. 1727.1

Johann Gabriel Gering, *respond.*

Anatomy described for Lampetra, Anguilla, Silurus, Acus, Asellus, Salmo, Spirinchus, and Albula.

—— (*præses*) Dissertatio de salmonum natura, eorumque apud Ostrobothnienses piscatione. Upsala, 1730. 27 p. fig. 4°. Pre-Linn. 1730.1

Dan. Bonge, *respond.*

—— Anatomia piscium figuris multis illustrata. (In Klein, J. T. Historia piscium naturalis provomendæ. Gedani, 1749, missus v, p. 2.) Pre-Linn. 1749.1

According to Gronovius, Klein received this in MS. from J. G. Waller and published it as noted.

Robinson, *Tancred* [–1748] [Notes on various fishes] [in] Appendix ad historiam naturalem piscium. (In Willughby, F. De historia piscium, etc. Oxonii, 1686. fol.) p. 27. Pre-Linn. 1686.1

—— Miscellaneous observations made about Rome, Naples, and some other countries in the year 1683 & 1684. Phil. Trans. Roy. Soc., 1715 (1717), **29**, 473–483. Pre-Linn. 1717.1

Treats of fishes among other things.

Rochefort, *César de* [1630–1691] Histoire naturelle et morale des îles Antilles de l'Amérique. Enrichie de plusieurs belles figures des raretez les plus considérables qui y sont décrites. Avec un vocabulaire Caräibe. Roterdam, 1658. 527 p. 43 pls. 4°. Pre-Linn. 1658.1

Editio princeps of a valuable work; not seen The dedication is signed "L. D. P." (i. e. Louis de Poincy); the book, however, was compiled by de Rochefort, whose name appears in the subsequent eds. Du Tertre avers that the bulk of the work was taken, errors included, from his own book, which appeared in 1654. Boehmer says there was an ed. at Rotterdam, 1639, but this seems to be an error. Often reprinted and translated, some titles of which follow.

The "Vocabulaire Caräibe" is by Père Raimond Breton (*q. v.* 1665.1 this section).

—— Natuurlyke en zedelyke historie van d'eylanden der Voor-Eylanden en America, etc. Rotterdam, 1662. Pre-Linn. 1662.1

—— Histoire naturelle et morale des îles Antilles de l'Amérique. Enrichie d'un grand nombre de belles figures en taille douce, des places et des raretez les plus considérables, qui y sont décrites. Avec un vocabulaire Caräibe, Rotterdam, 1665. xviii, 583 p. pls. ills. Pre-Linn. 1665.1

Fishes, p. 183–200.
The 2nd French ed., & probably the best. Others are: Rotterdam, 1681; Rouen, 1665; Paris, 1666; Lyons, 1667; Amsterdam, 1716. Dutch versions are: Rotterdam, 1658 & Frankfort, 1668.

—— The history of the Caribby-Islands, viz. Barbados, St. Christopher, St. Vincent's, Martinico, Dominico, Barbouthos, Monserrat, Nevis, Antego, etc., in all xxviii. In two books. The first containing the natural; the second, the moral history of those islands. With a Caribbian vocabulary. Rendered into English by John Davies of Kidwelly. London, 1666. sm. fol. Pre-Linn. 1666.1

Fishes, p. 97–106. Copy N. Y. P.
The rare first English version of the anonymous French edition of 1658, often catalogued under the name of the translator.

—— Historische Beschreibung der Antillen-Inseln in Amerika gelegen, etc. Frankfort, 1668. Pre-Linn. 1668.1

—— Relation du voyage de l'Isle Tabago. Paris, 1666. 8°. Pre-Linn. 1666.2

Fishes, p. 36–37. Copy, N. Y. P.
Inserted here to avoid breaking continuity of the above.

Rœde, *Christ.* (*præses*) Dissertatio de pisce, qui Jonam deglutivit, cujusnam speciei fuerit? Hafniæ, 1740. 4°. Pre-Linn. 1740.1

Frid. Colbiörnsen, *respond.*

Ronaudot, *Eus.*, & **Le Tellier,** *Pet.* *See* **Le Tellier & Ronaudot.**

Rondelet, *Gulielmus* [1507–1566] For sketches of the life of this author, *see* memoir by R. Hamilton, in Jardine's Naturalist's Library, 1845–46, vol. XXXVIII. Also Planchon, J. E. "Rondelet et ses disciples," etc. Montpellier, 1866. 72 p. 2 pls. Also Kingsley, G. "Sketch of the life of Rondeletius," in "Good Words." Sept. 1868.

—— Libri de piscibus marinis, in quibus veræ piscium effigies expressæ sunt. Quæ in tota piscium historia contineantur, indicat elenchus pagina nona et decima. Postremo accesserunt indices necessarij. Lugduni [Lyons], 1554. 14, 583, 23 p. ills. portrait. fol. Pre-Linn. 1554.1

The first four books have to do with the external and internal anatomy, the faculties and habits of fishes and the modes of capturing them. In the remaining books are described the fishes known to Rondelet. Although the title says "marine fishes," 47 freshwater fishes are described as against 197 marine.

—— Universæ aquatilium historiæ pars altera, cum veris ipsorum imaginibus. His accesserunt indices necessarii Lugduni, 1555. 10, 242, 9 p. ills. portrait. fol. Pre-Linn. 1555.1

This work is ordinarily considered as vol. II of the "Libri de piscibus marinis," but it has a separate title page and was published a year later than that work. Konrad Gesner included it in his "Historiæ animalium, liber IV," 1558. These two volumes, translated into French, next appear under the title below. They are, however, paged separately.

—— La première (et seconde) partie de l'histoire entière des poissons. Lion, 1558. 9, 418, 20, 181, 8 p. ills. portrait. fol. Pre-Linn. 1558.1

In 1558, Franciscus Boussuet published at Lyons two poems entitled "De natura animalium." Since his facts were obtained from Rondelet and the figures of "De piscibus marinis" were used as illustrations, these books are sometimes listed under Rondelet, but they are individual productions of, and are herein listed under Boussuet, (*q. v.*).

Rongeard, ——. Observations sur les vers des tanches. 1723. 4°. Pre-Linn. 1723.1

Rosenhane, *Gust.* Respublicæ glacialis seu de hiberna piscatione apud Suecos. Stockholm, 1681. 12°. Pre-Linn. 1681.1

Rousseau, *Cl.* Edicts et ordonnances, arrêts et réglements des eaues et forests, revues et augmentez d'anciens et nouveaux, avec annotations sommaires. Paris, 1633. 8°. Pre-Linn. 1633.1

French laws relating to freshwater fisheries.

Rudbeck (*junior*), *Olaus* (*præses*) [1630–1702] Ichthyologiæ biblicæ pars prima, de ave selav, cujus mentio fit num. xi: 31, in qua contra Bochartum & Ludolfum non avem aliquem plumosam, nec locustam fuisse, sed potius quoddam piscis genus (pisces volatiles) manifestis demonstratur argumentis. Upsaliæ, 1705. 148 p. figs. 4°. Pre-Linn. 1705.1

Andrew Brodd, *respond.*

Rumpf, *or* **Rumphius**, *George Everhard* [1626–1693] For a sketch of his life, *see* Henschel, A. W. E. T. "Vita G. E. Rumphii . . . accedunt specimen materiæ Rumphianæ medicæ clavisque herbarii et thesauri Amboinensis," &c. 1833. 8°. Also issued under the title "Clavis Rumphiana botanica et zoologica, accedunt vita G. E. Rumphii." For bibliography, *see* Rouffaer, G. P., & Muller, W. C., 1902.1. With reference to the fate of Rumpf's collections, *see* Martelli, U., 1903.1; also Targioni-Tozzetti, G., 1903.1

—— D'Amboinsche rariteitkamer, behelzende eene beschryvinge van allerhande zoo weeke als harde schaalvisschen, te weete raare krabben, kreeften, en diergelyke zeedieren, als mede allerhande hoorntjes en schulpen, die men in d'Amboinsche zee vindt. Amsterdam, 1705. xxviii, 340 p. 60 pls. ills. fol. Pre-Linn. 1705.1

Chap. LXXXII, Dominees Steen. In pl. 59 are shown figures of *Palæoniscus freieslebeni*, from the Permian, and of Leptolepis from the lithographic stone of Solenhofen.

This work as a whole or in its parts was often reprinted in Dutch and in various versions. Some editions of the original work are: Amsterdam, 1741; Wien, 1766. The best known Latin version is:

—— Thesaurus imaginum piscium testaceorum, quales sunt cancri, echini, &c. Lugduni Batavorum, 1711. 4, 15, 8 p. 60 pls. fol. Pre-Linn. 1711.1

Consists of the plates only, with names of the animals in Latin and Dutch. The fossil fishes above referred to are included.

Another ed., The Hague, 1739.

—— Het Amboinsche kruid-boek, etc. G. E. Rumphii . . . Herbarium Amboinense, etc. 6 parts [in 4 vols.]. Amsterdam, 1741–1755. Pre-Linn. 1741.1

Not seen; apparently a Dutch-Latin version of the above.

Rumpler, *Angelus* (*Abbot of Vormbach-am-Inn*) Geschichte des Klosters zu Vormbach. [M. S. *c.* 1500.] Pre-Linn. 1500.1

According to J. Wimmer in his "Geschichte des deutschen Bodens," p. 389–392, an interesting account of Bavarian fishes is contained in this work.

Russell, *Alexander* [*c.*1715–1768] An account of four undescribed fishes of Aleppo. Phil. Trans. Roy. Soc. 1756, **49**, 445–449. Pre-Linn. 1756.1

Three are silurids. No scientific names are assigned. Descriptions and figures of these also found in:

—— The natural history of Aleppo, and parts adjacent. Containing a description of . . . the principal natural productions in its neighbourhood, etc. London, 1756. viii, 266, 10 p. 16 pls. 4°. Pre-Linn. 1756.2

Abstracted and reviewed in Com. de Rebus, **7**. — Leipz. Gel. Anz., 1757. — Gött. Gel. Anz., 1757.

A second ed. (revised & enlarged by P. Russell) in 2 vols., illust. London, 1794 (fishes, vol. II, p. 207–219, pl.). German version, "Naturgeschichte von Aleppo." Göttingen, 1797–98.

Ruysch, *Fredericus* [1638–1731] Thesaurus animalium primus . . . Het eerste cabinet der Dieren. Amstelœdami, 1710. lvi, 40 p. 7 pls. Pre-Linn. 1710.1

11 Asiatic & African fishes described.

Latin and Dutch in parallel columns. Copy in A. M. N. H.

—— Descriptio anatomica rajæ (In Valentini, M. B. Amphitheatrum Zootomicum, 1720, pt. II, 125. pl. 74.) Pre-Linn. 1720.1

Ruysch, *Henricus* (*filius Frederici*) [–1727] Theatrum universale omnium animalium . . . ex scriptoribus tam antiquis quam recentioribus . . . a J. Jonston collectum, ac plus quam trecentis piscibus nuperrime ex Indias orientalibus allatis . . . cum enumeratione morborum . . . ac notitia animalium . . . cura H. Ruysch, etc. 2 vols. [in 1]. Amstelodami, 1718. fol. Pre-Linn. 1718.1

Fishes found in vol. I. only.

For the most part an edition of Jonston. (*q. v.*)

—— Collectio nova piscium Amboinensium partim ibi ad vivum delineatorum, partim ex museo Henri Ruysch M.D. xx tabulis comprehensa (in his Theatrum universale omnium animalium, etc. Amstelodami, 1718). 40 p. 20 pls. Pre-Linn. 1718.2

This is Ruysch's own part of the "Theatrum universale," but it is mainly taken from Renard and Valentyn. The figures are gross caricatures. *See* also Jonston, J., this section.

Rzaczynski, *Gabriel* [–1737] Historia naturalis regni Poloniae, magni Ducatus Lithuaniae, annexarumque provinciarum, in tractatus xx divisa, etc. Sandomiriæ, 1721. 456 p. sm. 4°. Pre-Linn. 1721.1

De fluminibus et piscibus. p. 131. De lacubus, piscibus, etc. p. 153.

—— Auctarium historiæ naturalis curiosæ regni Poloniæ. 12 parts. Gedani, 1736. 4°. Abstract in Erlang. Gel. Zeit., 1755. Pre-Linn. 1736.1

Other eds., Gedani, 1742 & 1745.

S

S., *J.* The true art of angling; or the best and speediest way of taking all sorts of fresh-water fish with the worm, fly, paste and other baits in their proper seasons; how to know the haunts of fish and angle for them in all waters and weathers, at the top, middle and bottom, baiting of the ground and night baits, oyls and oyntments, baits natural and artificial; the several ways of angling; . . . and many rare secrets never before made publick; containing the whole body of angling, and mystery of a compleat angler. London, 1696. vi, 160 p. 24°. Pre-Linn. 1696.1

This passed through at least 12 eds., in part under the above title, but mostly changed as below. The second ed. "The true art of angling," etc. London, 1697, like the above, is extremely rare. The third ed. is:

—— The compleat fisher, or the true art of angling; being a clear and speedy way of taking all sorts of freshwater fish . . . containing the . . . mystery of a compleat angler, etc. London, 1704. vi, 160 p. 24°. Pre-Linn. 1704.1

This was followed by eds. bearing same title; London, 1716, 1725, 1740, & 1770 (12th and last ed.) as "The true art of angling."

This author is believed to have been John Smith (*q. v.*, this section) and these titles are listed under his name in the Heckscher sale catalogue. See also, further in Westwood & Satchell under both authors.

Sagard-Theodat, *F. Gabriel* [*fl.* 17th cent.] Le grand voyage du pays des Hurons, situé en l'Amérique vers la mer douce, és derniers confins de la nouvelle France, dite Canada . . . De la chasse, de la pesche & des oyseaux & animaux terrestres & aquatiques, etc. Paris, 1632. 380 p. 16°. Pre-Linn. 1632.1

A practically new edition was issued, Paris, 1636, as "Histoire du Canada," etc. A modern reprint appeared in 1865.

Sainctyon, ——. Les édicts et ordonnances des roys, coustumes des provinces, réglemens, arrests et jugemens notables des eaux et forêts. 3 vols. Paris, 1610. fol. Pre-Linn. 1610.1

Early French laws governing fishing in fresh waters.

Saint Ambrose. *See* **Ambrose,** (*Saint*).

Saint Hildegard, *Abbess of Bingen. See* **Hildegarde de Pinguia.**

Saint Laurent, *Joannon de.* Description abrégée du fameux cabinet de M. le Chevalier de Baillou, pour servir à l'histoire naturelle des pierres précieuses, métaux, minéraux et autres fossiles. Luques, 1746. 156 p. 8°. Pre-Linn. 1746.1

Chap. 14, p. 93. Pétrifications. Les pétrifications des poissons, p. 93–96. (Anguille, Carcharias, brochets, dorades, sardines, turbots et tanches.)

Salenius, *Jo. G.* (*respond.*) Dissertatio de iure venationis et aucupii. Upsaliæ, 1663. 4°. Pre-Linn. 1663.1

D. Dan. Lipstorp, *præses.*

Salerne, *François* & **Arnault de Nobleville,** *L. D. See* **Arnault de Nobleville & Salerne.**

Sallengre, *Henr. de.* Antiquitatum Romanarum thesaurus novus. Hagæ Comitum, 1724. fig. Pre-Linn. 1724.1

"Tom. I. continet librum de piscibus."

Salmon, *Thomas* [1679–1767] Die heütige Historie der Sundaischen Inseln als Borneo, Java und Sumatra. Halle or Altona, 1733. pls. 4°. Pre-Linn. 1733.1

A few fishes named, but not described.

Saluste, *Guillaume de* (*Seigneur du Bartas*). *See* **Du Bartas,** *Guillaume de Saluste* (*Seigneur*).

Salviani, *Hyppolyto* [1514–1572]. For a biographical memoir, *see* Bushnan, J. S. in Jardine's Naturalist's Library, London, 1845–46, vol. XXXV.

—— Aquatilium animalium historiæ liber primus, cum eorundum formis aere excusis. Romæ, 1554–1558. 16, 256 leaves. 88 pls. portrait. Pre-Linn. 1554.1

92 Italian fishes are figured and described. There is also a table in which each fish is identified with that named by Aristotle, Oppian, Pliny, Athenæus, Aelian, and other authors; volume and page of these writers being cited. The Latin, Greek, and common names of each fish are also given.

Salviani, *H.*

This finely printed work, the plates of which in accuracy and beauty far surpass any figures published in the next 100 years, seems to have been issued in parts. The copy belonging to the A. M. N. H. bears date of 1554 on the title-page, and 1558 on the last page. A continuation of this work was promised, but not brought out.

Great difficulty is experienced in working out the editions of Salviani's book. The data is scant and contradictory. There are supposed editions of 1555 and 1557, which may be explained on the basis that the work was issued in parts as the fish were studied and the plates made. Engelmann (p. 442) definitely says that an edition was issued of 99 figs. on 82 leaves without text, in small folio and having the title of the 1554 edition. He also states that an Italian version was issued on March 20, 1559. The former of these is probably the next title (found in Boehmer, vol. II, pt. II, p. 52).

—— Icones piscium. Romæ, 1593. fol. Pre-Linn. 1593.1

Equally isolated is the following title, quoted from Bauer.

—— Historia de piscibus. Roma, 1593. figs. fol. Pre-Linn. 1593.2

Quite definitely established, however, are the following editions:

—— De aquatilium animalium eorundem formis. Venetiis, 1600. fol. Pre-Linn. 1600.1

Another folio ed., Venice, 1602.

Sannazaro, *Jacopo* [1458–1530] Piscatoria, etc. Romæ, 1526. 8°. Pre-Linn. 1526.1

Other eds. are: Naples, 1526; Venice, 1527 & 1528; Paris, 1527; Venice, 1533. Found also in:

—— Opera omnia Latine scripta. Venetiis, 1526. 8°. Pre-Linn. 1526.2

The Opera passed through many eds.: 4 at Venice, 1526–1725; 8 at Leyden, 1536–1592; and 4 at various places, 1609–1728.

For present day versions of Sannazaro, *see:*

"La egloghe piscatorie di A. S. S. recate in versi Italiani dal Cavaliere L. Biondi." Torino, 1823. 8°.

"De ecloga piscatoria thesim proponebat A. Campaux." Paris, 1859. 8°.

"The piscatory eclogues of Jacopo Sannazaro" edited with introduction and notes, by Wilfred P. Mustard. Johns Hopkins Press, Baltimore, 1914. 94 p. 8°.

Saunders, *James.* The compleat fisherman. Being a large and particular account of all the several ways of fishing now practised in Europe, with curious secrets in the art of fishing as well in the sea, as in lakes, rivers, or brooks. More particularly calculated for the sport of angling. Also, an account of the principal rivers, lakes, &c. in England, and what kinds of fish are found in them. London, 1724. vi, 234 p. pl. 12°. Pre-Linn. 1724.1

Another ed., London, 1725, entitled "The compleat troller." A 3rd ed. appeared, 1778, and the last, 1800, was "The fisherman, or, the art of angling made easy."

Saurmann, *Thomas* (*respond.*) Analysis exercitationes 225. J. C. Scaligeri ad Cardanum de piscium habitaculis et allelophagia, seu mutuâ Laniena. Inaug. Dissert. Wittebergæ, 1639. 4°. Pre-Linn. 1639.1

Martin Heins, *præses.*

Scaliger, *Julius Caesar* [1484–1558] For a brief sketch of the life and works of this very learned man who edited both Aristotle and Pliny with notes and comments, *see* R. C. Christie and John Edwin Sandys in Encyclopædia Britannica, 1911, Vol. XXIV, p. 283.

—— Exotericarum exercitationum liber xv. de subtilitate ad Hieronymum Cardanum. Lutitiæ [Paris], 1557. 476 folios. Pre-Linn. 1557.1

Fishes in Exercitationes, nos. 201 & 225. Echeneis as a shipholder.

This work passed through many editions: Basel, 1560; Leyden, 1615; Hanoviæ, 1634; & Frankfort, 9 editions, 1572–1672.

Scheffer, *Henric Theophil* [1710–1759] Aanmärkningar öfver Nicol Seländer's svar, hurn en sädan lykta mä kunna redastil, at liuset kan deruti brinna om natte tid under vatnet in en siö, och säledes med skenet locka in fisken uti nägon behändig fiske-bradg? K. Swensk. Vetensk. Acad. Handl., 1750, 67. Pre-Linn. 1750.1

—— Anmerkung über N. Seländer's Frage, wie eine Laterne zu zubereiten ist, dass in ihr das Licht bey Nacht unter dem Wasser in einem Teiche brennen und also mit seinem Scheine die Fische in ein Netz locken kann. König. Schwed. Akad. Abhandl., 1750, 68. Pre-Linn. 1750.2

See note under Kästner, A. G., this section.

Scheffer, *Johanes* [1621–1679] Lapponia id est regionis Lapponum et gentis nova et verissima descriptio, etc. Francofurti, 1673. xiv, 380 p. ills. 4°. Pre-Linn. 1673.1

Contains some account of Lapland fishes.

A 2nd ed., Frankfort, 1678. A German version appeared at Frankfort & Leipzig, 1675. Other foreign versions follow.

—— The history of Lapland. Oxford, 1674. 147 p. fol. Pre-Linn. 1674.1

In another English ed., containing other works on Lapland, London, 1704.

—— Histoire de la Lapponei, etc. Paris, 1678. ills. 4°. Pre-Linn. 1678.1

—— Waerachtige in aen-merkenswaerdige historie van Lapland, etc. Amsterdam, 1682. Pre-Linn. 1682.1

Fishes, book ii, p. 107–109; book iii, p. 25–28, 72.

Scheffer, *S.* (*aus Görlitz*) (*respond.*) Exercitium juridicum de jure venandi, aucupandi et piscandi. Jenæ, 1638. 4°. Pre-Linn. 1638.1

Johann Fibig, *præses.*

Schelhammer, *Günther Christopher* [1649–1716] Anatomes Xiphiæ piscis, oceani incolæ, cultro anatomico MDCCIV in Academia Kilonensi subjecti brevis enarratio ad P. Hottonem: cui accedit Lumpi & Ophidii ejusdem generis breve examen. Hamburgi, 1707. 24 p. pl. 4°. Pre-Linn. 1707.1

Abstract, Nouv. Litt. Germ., Hamburg, 1708, p. 119.
This paper was broken up and the description of each fish published separately as:

—— Anatome Anglorum piscis [*Cyclopteri lumpi*]. Ephemer. Acad. Nat. Cur., 1712, cent. 1 & 2, append., 126–128. Pre-Linn. 1712.1

—— Anatome Ophidii piscis. Ephemer. Acad. Nat. Cur., 1712, cent. 1 & 2, append., 128–129. Pre-Linn. 1712.2

—— Anatome Xiphiæ piscis. Ephemer. Acad. Nat. Cur., 1712, cent. 1 & 2, append., 110–126. Pre-Linn. 1712.3

—— Descriptio anatomica Xiphiæ piscis (In Valentini, M. B. Amphitheatrum Zootomicum, 1720, pt. 2, 102–110. pl.) Pre-Linn. 1720.1

In this reprint, although the title says anatomy of Xiphias only, all 3 fishes are considered.

Scheuchzer, *J. G.* (*filius J. J.*) (*translator*) *See* Kaempfer, E. The history of Japan, etc. 1727.

Scheuchzer, *Johann Jacob* [1670–1733] A bibliography (1694–1721, — 47 p.) is found at the end of his "Itinera per Helvetiæ alpinas regiones facto annis 1702–11." 4 vols. Leiden, 1723. 4°.

—— Physica oder Naturwissenschaft. 2 vols. [in 1]. Zurich, 1703. 300 & 300 p. 8°. Pre-Linn. 1703.1

Vol. II, Von den Fischen, p. 405–411.
Augmented eds.: Zurich, 1711, 1729, 1743. 1729 ed. seen by us. 110 fishes named & structures discussed, vol. II, chap. xxxvi.

—— Beschreibung der Naturgeschichte des Schweizerlandes. 3 vols. Zurich, 1706–18. 4°. Pre-Linn. 1706.1

Fossil sharks' teeth, vol. II, p. 143.

—— Piscium querelæ et vindiciæ. Tiguri, 1708. 36 p. 5 pls. 4°. Pre-Linn. 1708.1

For a critique of this work, *see* Roche, A., & Demontmerot, C. 1897.1.

—— Bildnissen verschiedener Fischen, und dero Theilen welche in der Sündfluth zu Grund gegangen. Zurich, 1708. 8 p. 5 pls. 4°. Pre-Linn. 1708.2

An abbreviated German version of the above, which is also found in his:

—— Epistola ad Bajerum. Acta Phys. Med., 1708, append., p. 92. Pre-Linn. 1708.3

—— Herbarium diluvianum. Zurich, 1709. fol. Pre-Linn. 1709.1

Some fossil fishes described. Augmented ed., Leyden, 1723, 119 p. 14 pls. — fossil fishes, p. 8–10, 22 (fig. 7, pl. v), 44 (fig. 6, pl. ix).

—— Bibliotheca scriptorum historiæ naturalis omnium terræ regionum inservientium. Historiæ naturalis Helvetiæ prodromus. Tiguri, 1716. 8°. Pre-Linn. 1716.1

Another ed., augmented by J. Le Long by the inclusion of "scriptores historiæ naturalis Galliæ," Zurich, 1751. xiv, 241 p. 8°.

—— Museum diluvianum. Tiguri, 1716. 107 p. 8°. Pre-Linn. 1716.2

Some fossil fishes described.

—— Meteorologia et oryctographia Helvetica. Zürich, 1718. 336 p. pls. 4°. Pre-Linn. 1718.1

Fossil fishes, with figs., p. 333–336.

—— Biblia ex physicis illustrata quibus res naturales in Scriptura Sancta occurentes exhibentur, figuris nitidis a J. A. Pfeffel sculptis. 4 vols. Augustæ Vindelicorum, 1731–35. fol. Pre-Linn. 1731.1

This seems to be the original ed. Other eds. & versions are:

—— Physica sacra. Iconibus æneis illustrata, etc. 4 vols. Augustæ Vindelicorum, 1731–35. 1536 p. 750 pls. Pre-Linn. 1731.2

—— Kupferbibel in welcher die Physica sacra oder geheiligte Naturwissenschaft derer in heiliger Schrift vorkommenden natürlichen Sachen, deutlich erklärt und bewährt, etc. 4 vols. Augsburg & Ulm 1731–1735. Pre-Linn. 1731.3

—— Physique sacrée, ou histoire-naturelle de la Bible, traduite du Latin. 8 vols. Amsterdam, 1732–1737. 750 pls. fol. Pre-Linn. 1732.1

Vol. I, p. 25, pl. 15 — The Creation (fifth day) — fishes: p. 68, pl. 53 — The results of the Deluge — fossil sharks' teeth; p. 68–70, pls. 54–57 — Fossil fishes.
Vol. III, p. 79–80, pls. 238–239 — Scaled fishes permitted to be eaten by the Jews — eel, lamprey and sole (Leviticus xi, 9–12).

Scheuchzer, *J. G.*
Vol. VI, p. 54–55, pl. 518 — Fishes of the sea — internal organs of the pike (Job xii, 8).
Vol. VII, p. 238–239 — Leviathan = a tunny (pl. 557) or a hammerhead shark (pl. 610) (Psalm lxxiv, 14): p. 462–466, pl. 650 — Jonah's great fish = a shark (Lamia).
Vol. VIII, p. 134–135, pl. 713 — The miraculous draught of fishes (Luke v, 4–7): p. 250–252, pl. 745 — The scorpion = Scorpæna.
Copy, N. Y. P.

—— Geestelyke Natuurkunde. 15 deelen [in 8]. Amsterdam, 1735. fol. Pre-Linn. 1735.1

A later Dutch ed. is: "Bijbel der Natuur." Amsterdam, 1784. roy. 8°.

Schillinger, *Franc. Kasp.* Vierjährige persianische und ostindische Reise, neben Beschreibungen vieler orientalischen Völker, mit Darstellung derer zahmen und wilden Thiere in Indien, wie auch Vögeln, Fischen, Früchten, Erd und Seegewächsen. Nürnberg, 1707. 8°. Pre-Linn. 1707.1

Another ed., Nürnberg, 1716.

Schnurr, *Balthasar.* Kunst- Haus- und Wunderbuch, darinnen allerhand . . . Fischen . . . gehandelt wird . . . . Auffs new verbessert, vermehrt und mit einem nutzlichen Register gezieret. Nürnberg, 1654. 8°. Pre-Linn. 1654.1

Another ed., Frankfurt, 1664, 1878 p.

Schonevelde, *Stephanus A.* Ichthyologia et nomenclaturæ animalium marinorum, fluviatilium, lacustrium, quæ in florentissimis ducatibus Slesvici et Holsatiæ et Emporio Hamburgo occurrunt triviales; ac plerorumque hactenus desideratorum imagines, breves descriptiones et explicationes. Hamburgi, 1624. 85 p. 7 pls. 4°. Pre-Linn. 1624.1

Contains a list of fishes in alphabetical order in both Latin and Teutonic. Anatomy given of herring, catfish and dogfish.

Schoock, *Martin* (*præses*) [1614–1669] Dissertatio de harengis, vulgo halecibus dictis. Groningiæ, 1649. 8°. Pre-Linn. 1649.1

Ant. Mattheus, *respond.*

Schott, *Gaspar* [1606–1666] For critical notes on the work listed below, *see* St. Leger, Abbé de, "Notice raissonnée des ouvrages de Gaspar Schott, Jésuite: contenant des observations curieuses sur . . . l'histoire naturelle et les arts." Paris, 1785. 103 p. 8°.

—— Physica curiosa, sive mirabilia naturæ et artis libris XII comprehensa, quibus pleraquæ quæ angelis dæmonibus, hominibus, spectris, energumenis, monstris, portentis, animalibus, meteoris, etc. 2 vols. Herbipoli, 1662. 1583 p. 57 figs. Pre-Linn. 1662.1

De mirabilibus animalium aquatilium, vol. II, lib. x, p. 1256–1385. Echeneis as a shipholder.
The 1st ed.; others, Herbipoli, 1667 & 1697.

Schrassert, *Joh.* Hardervicum antiquum ofte beschryvinge der stadt Harderwijck. Harderwyck, 1732. 2 parts. 4°. Pre-Linn. 1732.1

Contains data about fishing in Zuiderzee.

Schroeder, *Johann* [1600–1664] Zoologica, or the history of animals as they are useful in physick and chirurgery . . . Translated by T. Bateson. London, 1659. vi, 159 p. 8°. Pre-Linn. 1659.1

Fishes used in medicine, p. 111–133. Copy, H.

—— The compleat chymical dispensatory, in five books: treating of all sorts of metals, precious stones, and minerals, of all vegetables and animals . . . &c. Englished by W. Rowland. London, 1669. iii, 445 p. fol. Pre-Linn. 1669.1

Not seen. Presumably an enlarged issue of the above.

Schwalbe, ——. Lactes et ova simul in uno carpione. Comm. Litt. Norimbergæ, 1734, p. 305. Pre-Linn. 1734.1

Schwenckfeld, *Caspar* [1563–1609] Theriotropheum Silesiæ in quo animalium, hoc est, quadrupedum, reptilium, avium, piscium, insectorum, natura, vis et usus sex libris perstringuntur: concinnatum et elaboratum, etc. Lignicii [Lignitz], 1603. xxiv, 568 p. 4°. Pre-Linn. 1603.1

40 Silesian fishes are described.
Second ed., Lignicii, 1604.

Scilla, *Agostino* [1639–1700] For a biography, *see* Seguenza, G. "Agostino Scilla." Messina, 1868.

—— La vana speculazione disingannata dal senso. Lettera risponsiva circa i corpi marini, che petrificati si trouano in varij luoghi terrestri, etc. Napoli, 1670. 168 p. 28 pls. 4°. Pre-Linn. 1670.1

Reviewed anonymously in Phil. Trans. Roy. Soc., 1698, **19**, 181–201.

—— De corporibus marinis lapidescentibus quæ defossa reperiuntur, auctore Augustino Scilla, addita dissertatione Fabii Columnæ de glossopetris. Romæ, 1747. 73 p. 28 pls. frontisp. Pre-Linn. 1747.1

Lapides bufonites (teeth of Sargus) and glossopetras (teeth of sharks) described with elegant copper-plate figures.

The first Latin version of Scilla. Others: Rome, 1752 (copy, A. M. N. H.) & 1759.

Scribonius, *G. A.* Rerum naturalium doctrina methodica. Basilia, 1587. 8°. Pre-Linn. 1587.1

Fishes of Switzerland considered.

Seba, *Albert* [1665–1736] Locupletissimi rerum naturalium thesauri accurata descriptio et iconibus artificiosissimis expressio, per universam physicis historiam . . . Ex toto terrarum orbe collegit, digessit, descripsit, et depingendum curavit Albertus Seba. 4 vols. Amstelædami, 1734–1765. 449 pls. gr. fol. Pre-Linn. 1734.1

Half title reads: "Description exacte des principales curiositez naturelles du magnifique cabinet d'Albert Seba." Text in Latin and French.

Vol. I, 1734: *Rana piscatrix* — Pterophryne & Malthe, p. 118–119, pl. 74; fish stages in frog evolution, p. 125, pl. 78. Vol. III, 1758; fishes, p. 58–109, pls. 23–34.

Seelen, *Erich Gottlieb von.* (*respond.*) Dissertatio specimen pharmacologiæ sacræ de antimonio, cicuta et pisce Tobiæ sive siluro. Gryphiswaldæ, 1708, 34 p. 4°. Pre-Linn. 1708.1

Christ. Helvig, *præses.*

Seger, *George* [–1678] De piscium auditu. Ephemer. Acad. Nat. Cur., 1673–74 (1688), dec. 1, ann. 4 & 5, 142–143. Pre-Linn. 1688.1

Seger, *Jo. Lud.* Landwirthschaftliche Teich- und Weyherluft, oder gründliche Information zur edlen Fischerey. Francofurti, 1727. 8°. Pre-Linn. 1727.1

Seguyn, *Pet.,* & **Chasler,** *Hug.* Ergo piscium usus vere salubris. Paris, 1628. Pre-Linn. 1628.1

Not seen. Title from Boehmer.

Selanders, *Nicolas.* Responsio super quæstionem: quomodo talis lucerna parari posset in qua nocturno tempore lux sub aqua fluminis vel stagni servetur eaque pisces ad commodum receptaculum alliciantur? Comm. Litt. Norimbergæ, 1744. Pre-Linn. 1744.1

Not seen; title from H. Cloquet.

Selincourt, *Jaques Epée de.* L'art de toute sorte de chasse et de pêche, avec celui de guerir les chevaux, les chiens et les oiseaux. 2 vols. Amsterdam, 1711. 12°. Pre-Linn. 1711.1

Other eds.: Lyons, 1719 & 1722. Probably a reprint of Louis Liger. (*q. v.*)

Semeyns, *Meynert.* Een corte beschryvinge over de haringvisscherij. Camerling, 1639. 8°. Pre-Linn. 1639.1

3rd ed. Others not known.

Sennert, *Daniel* [1572–1637] Physica hypomnemata. Lugduni, 1637. 471 p. Pre-Linn. 1637.1

Fossil fishes, p. 427. Copy, Col.

Serres, *Olivier de* (*Seigneur du Prade*) [1539–1619] Le théatre d'agriculture et mesnage des champs. Paris, 1600. fol. Pre-Linn. 1600.1

Livre v, chap. XIII, treats of "L'estang, le pescher, le vivier."

Numerous eds., at least 17 before 1675. Modern ed. Paris, 1802.

Severinus, *Marcus Aurelius* [1580 *or* 84–1656] Zootomia democritea, id est anatome generalis totius animantium opificii, libris quinque distincta, quorum setiem sequens facias delineabit. Noribergæ, 1645. 408 p. figs. 4°. Pre-Linn. 1645.1

Anatomy of herring, sardine and dog-fish, with figures of viscera.

Cuvier & Valenciennes say that this was the first general and philosophic treatise on comparative anatomy.

—— De piscibus in sicco viventibus commentarius in libellum Theophrasti Eresi; naturæ & Aristotelis interpretis summi . . . De radio turturis [pastinacæ] marini [De radio trigonos marini] Napoli, 1655. iv, 70 p. fol. Pre-Linn. 1655.1

—— Antiperipatias, hoc est, adversus Aristoteleos de respiratione piscium diatriba. Napoli, 1659. xx, 128 p. fol. Pre-Linn. 1659.1

Fishes respire air by gills but also possess an air breathing organ (air-bladder).

Other eds., according to Agassiz: Amsterdam & Naples, 1661; & Naples, 1665. The former of these, issued at Amsterdam, in A. M. N. H.

The two preceding numbers are bound in one volume and are in catalogues listed under the title "Antiperipatias," etc. For the discrepancies in dates, *see* the following note from the catalogue of the British Museum (Natural History) (vol. IV, 1906).

"The date to the dedication and imprimatur is 1659; that on the title-page to the part 'De Piscibus' is 1655 and to its dedication 1646; whilst the preface to 'Phoca illustratus' is dated 1645, and its peroratio 1646. The 'De radio turturis marinæ,' the running title of which reads 'De radio trigonos marini,' is dated 1644."

—— Anatome arengæ atque sardæ (In Valentini, M. B. Amphitheatrum Zootomicum, 1720, pt. 2, 133.) Pre-Linn. 1720.1

Sibbald, (*Sir*) *Robert* [1641–1722] For memoir, *see* Jardine, (*Sir*) William (In his Naturalists' Library, 1841, vol. XX; also 2nd issue, 1845–46, vol. I).

Sibbald, *R.*
—— Scotia illustrata sive prodromus historia naturalis. Edinburgh, 1684. 382 p. fol. Pre-Linn. 1684.1

In parts paged separately.
"Pars secunda specialis. Tomus secundus, De animalibus Scotiæ — De piscibus," p. 22–26. pls. (7 fishes figured.)
2nd ed., Edinburgh, 1696.

—— The history ancient and modern of the sheriffdoms of Fife and Kinross, with the description of both, and of the firths of Forth and Tay, and the islands in them; with an account of the natural products of the land and waters. Edinburgh, 1710. fol. Pre-Linn. 1710.1

Fishes, p. 118–129.
1st ed. Reprinted, 1803 — an exact copy. Copy, N. Y. P.

—— A advertisement anent the Xiphias or swordfish exposed at Edinburg. [n. p., n. d.]

Sidren, *J.* De materia medica e regno animali dissertatio. Upsala, 1750. 24 p. Pre-Linn. 1750.1

Fishes, p. 293–295.
As a separate. Another issue in Linnæus, C. Amœnitates Academicæ, 1751, **2**, no. 28; also in other eds. of this latter, 1762, & 1787. Copy, H.

Siegesbeck, *Johannes Georg* [1686–1755] Anmerckung über die denen Annalibus Medico Physicis Part. XVI, p. 635, inserirte Relation von dem Fische Carcharias, und zugleich über die beygefügte Meinung derer Gelehrten: Das der Prophet Jonas von keinem Wallfisch, sondern vielmehr von einem solchen Raubfische Carcharias verschlungen worden. Samml. Nat. u. Med. Kunst. u. Litt.-Gesch. Breslau, 1725, sect. 31, 67. Pre-Linn. 1725.1

Silos, *Guiseppe.* Lettera al Sig. Pier Carlo Benvenuti sopra la pesca del pesce Spada. (In Scelte delle lettere memorabili, raccolto dall' ab Michele Giustiniani. Napoli, 1683. p. 153.) Pre-Linn. 1683.1

Simson, *Archibald* [*c.* 1564–1628] Hieroglyphica animalium, terrestrium, volatilium, natatilium, reptilium, insectorum, vegetivorum, metallorum, lapidum, etc., quæ in Scripturis Sacris inveniuntur et plurimorum aliorum, cum eorum interpretationibus. Edinburgi, 1622. 218 p. 4°. Pre-Linn. 1622.1

Lib. III. De natatilibus. 19 p.
2nd ed., Edinburgh, 1692.

Sincerus, *Alexander.* Der in allerlei ergötzlichkeiten vergnügte Landmann darinnen allerhand zum Vögelfang, Schiessen, Jagen und Fischerei dientliche Künste enthalten sind. Nürnberg, 1720. 12°. Pre-Linn. 1720.1

2nd ed. Nürnberg, 1734.

Sloane, (*Sir*) *Hans* [1660–1753] For memoirs, *see* Jardine, (Sir) W. in Naturalist's Library, 1836, vol. XIII; or *Ibid.*, 1845–46, vol. XXIII. Also Jaeger, B. (In his Life of North American Insects, etc. 1854.) Short sketches are in: Mém. Acad. Sci. Paris, 1758; Bibl. Sci., **10**, pt. II, 280; Leips. Gel. Zeitg., 1753, 233; Tübing. Bericht., 1753, 10. St; Erlang. Gel. Beytr., 1753, 237.

—— An account of the tongue of a *Pastinaca marina,* [Aëtobatis] frequent in the seas about Jamaica and lately dug up in Maryland and England. Phil. Trans. Roy. Soc., 1697, **19**, 674–676. Pre-Linn. 1697.1

—— A voyage to the islands Madera, Barbados, Nieves, S. Christophers and Jamaica, with the natural history of the herbs and trees, four-footed beasts, fishes, birds, insects, reptiles, &c., of the last of those islands, . . . Illustrated with the figures of the things describ'd which have not been heretofore engraved. 2 vols. London, 1707–25. cliv, 264, 156; xviii, 499 p. 270 pls. Pre-Linn. 1707.1

Sloane's work and plates were constantly cited by writers of the 18th century, as Catesby, Edwards, Brisson, Linnæus, etc. and are often referred to still.

Agassiz notes a German version by Bernstiel, Berlin, 1764. Engelmann, however, shows this to be a translation of an English description of Sloane's collections.

—— Observations sur la castration des poissons pour les engraisser. Mém. Acad. Sci. Paris, 1742 (1745), hist., 31–32. Pre-Linn. 1745.1

Extract from a letter from Sloane to Geoffroy, giving an account of experiments performed by Samuel Tull. *See* in this connection, Watson, W. 1754.1, this section.

"Sir Hans Sloane died in 1753, 93 years of age, leaving his library of fifty thousand volumes, a cabinet of two hundred volumes of dried plants, and an immense collection of other objects in natural history, chiefly accumulated by himself, to be offered to the nation for twenty thousand pounds. This purchase being made by the Government, originated the British Museum."

Smallegange, *M.* Nieuwe cronyk van Zeeland. Eerste (één̈ig) deel. Vervattende de voor dezen uitgegeven cronyken van de Heeren Jacobus Eyndius, en Johan Reygersberg. . . . etc. Middelburg, 1696. fol. Pre-Linn. 1696.1

Contains data about fishes and fisheries, pp 178–192.

Smith, *Charles* [*c.* 1713–1762] Antient and present state of the county of Down . . . with the natural civil history of the same, etc. Dublin, 1744. 8°. Pre-Linn. 1744.1

Fishes, p. 235–241. The herring fishery, p. 241–250.

—— Ancient and present state of the county of Waterford, being a natural . . . and topographical description thereof, etc. Dublin, 1746. 8°. Pre-Linn. 1746.1

"Of the fish and fisheries on the coasts of this county, and of the Nymph-Bank," p. 259–279.
2nd ed., Dublin, 1774.

—— Ancient and present state of Cork. 2 vols. Dublin, 1750. 4 pls. 8°. Pre-Linn. 1750.1

Vol. II, book IV, chap. 5, "Of the fish and fisheries on the coasts of this county," p. 299–319.

—— Natural and civil history of the county of Kerry. Dublin, 1756. 8°. Pre-Linn. 1756.1

Contains a chapter on the fish and fisheries of this county.

Smith, *George.* The angler's magazine; or necessary and delightful storehouse; wherein everything proper to be known relating to his art is digested in such a method as to assist his knowledge and practice upon bare inspection; being the compleatest manual ever published upon the subject; largely treating on all things relating to fish and fishing, *etc.* London, 1754. 12°. Pre-Linn. 1754.1

Published anonymously but known to be by this author.
Text in the form of a dictionary.
Enlarged ed., London, 1760. Followed by "The laboratory: or school of arts," etc. London, 7 eds., 1799–1810. *See* Smith, G. 1799.1.

Smith, *John.* Profit and pleasure united, or the husbandman's magazine . . . To which is added the art of angling . . . etc. London, 1684. iv, 120 p. ills. 12°. Pre-Linn. 1684.1

Another ed., London, 1704. 167 p.
This author is believed to have been the J. S. under whom certain titles are listed in this section. *See* note under S., J., and also in Westwood & Satchell.

Smith, (*Capt.*) *John* [1580–1631] For a memoir, *see* Simms, W. G. "The life of Captain John Smith, founder of Virginia." New York, 1846.

—— A map of Virginia; with a description of the countrey, the commodities, people, government and religion. Oxford, 1612. Pre-Linn. 1612.1

List of fish found in Chesapeake Bay.
Smith wounded by a stingray.
This work, generally known as "The Description of Virginia," has been reproduced in Tyler, L. G. (editor) "Narratives of early Virginia, 1606–1620." New York, 1907.

—— A description of New England: or, the observations & discoveries of Captain John Smith (Admirall of that country) in the North of America, in the year of our Lord 1614 . . . etc. London, 1616. Pre-Linn. 1616.1

Fishing and food-fishes.
Reprinted in Force's Historical Tracts, **2**, tract 1. Extracts in Rept. U. S. Fish Comm. 1871–72 (1873) 152–153. Turned into Latin as:

—— Vera . . . descriptio navigationis in Novam Angliam . . . sub Capitaneo J. Schmidt (In De Bry. Voyages [America, pt. x. Latin], 1619). Pre-Linn. 1619.1

—— New England's trials. Declaring . . . the benefit of that country by sea and land, etc. Second ed. London, 1622. Pre-Linn. 1622.1

The abundance of food-fishes.
Reprinted in Force's Historical Tracts, **2**, tract 2. Extracts in Rept. U. S. Fish Comm. 1871–72 (1873), 153–154.

—— The generall historie of Virginia, New England, and the Summer Isles: with . . . the maps and descriptions of all those countryes, their commodities, people, government, customes, and religion yet knowne. Divided into sixe bookes. London, 1624. fol. Pre-Linn. 1624.1

Reissued with changed title page, 1626, 1627, 1632. Also found in Pinkerton's Voyages, 1812, vol. XIII; included in Arber's edition of Smith's complete "Works." London, 1884; and reprinted at Richmond, Virginia, 1890.

—— The description of Virginia by Captain John Smith inlarged out of his written notes. (In Purchas his Pilgrims, 1625, **4**, lib. LX, cap. iii, p. 1691–1704.) Pre-Linn. 1625.1

Fishes, p. 1692–1695.
Taken from entry 1612.1.

—— Advertisements for the inexperienced planters of New England, or anywhere. Or, the pathway to experience to erect a plantation. London, 1631. Pre-Linn. 1631.1

Sturgeon and cod-fishing.
Reprinted in Coll. Mass. Hist. Soc., 1833, 3. ser. **3**. Extracts in Rept. U. S. Fish Comm. 1871–72 (1873). 151.
In addition to the reprints noted in footnotes to each title, two complete modern versions of Smith's works are:

The adventures and discourses of Captain John Smith, sometime president of Virginia and admiral of New England. Newly ordered by John Ashton, London, 1883.

Smith, *J.*
Travels and works of Captain John Smith. President of Virginia and Admiral of New England, 1580–1631. Edited by Edward Arber, with a biographical and critical introduction by A. G. Bradley. 2 vols. Edinburgh, 1910. cxlvi, 984 p. ills.

Smith, *William.* A natural history of Nevis and the rest of the English Leeward Charibee Islands in America. Cambridge, 1745. 318 p.
Pre-Linn. 1745.1

Fishes (dolphin, shark, etc.), p. 3, 18, 182–206. Fishing with the "Dog-wood" bark, p. 3–4.

Solinus, *Caius Julius* [*fl.* 3rd. cent. A. D.] Polyhistor; de mirabilibus mundi. [Rome, *c.* 1475]. 8°.
Pre-Linn. 1475.1

This work, written about 325 A.D., is essentially an abridgment of portions of Pliny's "Natural History," arranged from the geographical point of view, and greatly enlarged. The compilation was revised in the 6th century, and then received the name of "Polyhistor." Six or seven species of fish are described.

Other 15th cent. eds. are: Venice, 1473, 1491, 1493, 1498; Parma, 1480; Brescia, 1498; Bologna, 1500.

Copies 1st ed., H., H. E. H.; of other eds., N. Y. P., L. C., & H. E. H.

Title Brescia ed. reads:

——Collectanea de mirabilibus mundi. Brixiæ [Brescia], 1498. fol.
Pre-Linn. 1498.1

Some later eds. are: Poitiers, 1554; Antwerp, 1572; Gotha, 1665; Leipsic & Nuremberg, 1777. An English version is:

—— The excellent and pleasant work of Julius Solinus. Polyhistor . . . Translated out of Latin into English by Arthur Golding, Gent. London, 1587. 4°. [Blk. letter]
Pre-Linn. 1587.1

This contains the life of Solinus by John Camertes.

A modern ed. of the works of Solinus is:

C. Julii Solini collectaneo rerum memorabilium. Iterum recensuit Th. Mommsen. Berlin, 1895. cv, 276 p. 8°.

Soto, *Hernando de* [*c.* 1500–1542] *See* **Fidalgo de Elvas.**

Spada, *Giovanni Giacomo* [1680–1774] Dissertazione ove si prova, che li petrificati corpi marini, che nei monti adiacenti a Verona si trovano, non sono scherzi di natura, nè diluviani; ma antidiluviani. Verona, 1737. 23 p. 4°.
Pre-Linn. 1737.1

—— Giunta alle dissertazione de' corpi marini petrificati; acced. diss. de plantis veronensibus. Verona, 1737. 18 p. 4°. Pre-Linn. 1737.2

—— Catalogus lapidum Veronensium, IDIOMORPHON, id est propria forma præditorum, qui apud Joannem Jacobum Spadam, etc. asservantur. Veronæ, 1739. 31 p. gr. 4.
Pre-Linn. 1739.1

—— Catalogi lapidum Veronensium mantissa. Veronæ, 1740.
Pre-Linn. 1740.1

—— Corporum lapidefactorum agri Veronensis catalogus quæ apud J. J. Spadam . . . asservantur. Editio altera . . . cui accedunt annotationes, etc. Veronæ, 1744. 81 p. illust. 4°.
Pre-Linn. 1744.1

All Spada's works contain references to Eocene fishes of Monte Bolca.

Spener, *Christ. Maximilian.* Catalogus zahlreicher, nutzlicher und sonderbahrer von Natur und Kunst gebildeter Seltenheiten in Regno Animali, rahrer Preparatorum und in Spiritu Vini conservatorum von . . . Fischen, . . . auch andern Indianischen und Europæischen . . . See-Thieren . . . Petrificata antediluviana, verschiedene Thiere, Fischen, Muscheln, &c. Berlin, 1718. figs. 8°. Pre-Linn. 1718.1

Sperling, *Jo.* [*c.* 1603–1658] (*præses*) Dissertatio de respiratione piscium. Wittebergæ, 1637. 2 pl. 4°.
Pre-Linn. 1637.1

Eccard, *respond.*

—— Exercitationes physicæ. Wittebergæ, 1663. Pre-Linn. 1663.1

Creation and generation of fishes, p. 684–686. Copy, Col.

Stade, *Hans* [1520–1565] Wahrhaftig Historie und Beschreibung einer Landschaft der wilden, nacketen, grimmigen Menschenfresserleuten, in der neuen welt Amerika gelegen. Marburg, 1557. Pre-Linn. 1557.1

For a list of the 21 subsequent editions and translations of this work, *see* introduction to the Portuguese version by A. Löfgren published by Instituto Historico e Geographico de São Paulo, Brazil, in 1900. Among the facsimile illustrations is a fishing scene in chapter 7, p. 128.

For English readers this book is best available as:

The captivity of H. Stade . . . in A. D. 1547–1555, among the wild tribes of eastern Brazil, etc. (In Hakluyt Soc., Works, 1874, no. 51.)

Staentzl de Cronfels, *A. L.* Piscinarium, oder Teicht Ordnung warinnen von Erbawung der Teichte, derselbten Tämme, Röhren Ablass . . . von Erziegung und Versetzung der

Fisch . . . gehandlet wird. Ollmütz, 1680. 182 p. 8°. Pre-Linn. 1680.1

Starcke, *J. Henri.* De pisce hermaphrodito. Ephemer. Acad. Nat. Cur., 1699 (1700), dec. 3., ann. 7 & 8, 109. Pre-Linn. 1700.1

Steele, (*Sir*) *Richard* [1672–1729], & **Gillmore,** *Joseph.* An account of the fish pool. Consisting of a description of the vessel so-call'd, lately invented and built for the importation of fish alive and in good health, from parts however distant . . . London, 1718. 60 p. pls. 12°. Pre-Linn. 1718.1

At London, 1790, was issued "The town talk, the fish pool," etc. by Sir Richard Steele, — evidently a reprint of the above. The account of "The fish pool," p. 187–236.

Steensen, *Niels. See* **Steno,** *Nicolaus.*

Stegmann, *Ambrose.* De lue pennatorum et piscium morbis. Miscell. Acad. Nat. Cur., 1697 (1698), dec. 3, ann. 5 & 6, 385–386. Pre-Linn. 1698.1

Steinbock, *Ernst Friedrich von.* Unterricht von der Nutzbarkeit der Fischerei. Nürnberg, 1710. 8°. Pre-Linn. 1710.1

—— Die noch nie genug gepriesene Kunst der edlen und hochschätzbaren Fischerey, samt allen deren Nothwendigkeiten; erstlich, in Erwählung und Bestellung derer dazu gehörigen Wasser, die Teiche zu bauen und anzulegen; ferner wie und wann die Fische zu besetzen, . . . und zu fangen, etc. Nürnberg, 1730. xiv, 374, xxvi p. pls. 8°. Pre-Linn. 1730.1

—— Die noch nie genug gepriesene Kunst der Fischerei, nebst Beschreibung der Fische. Nürnberg, 1750. pls. 8°. Pre-Linn. 1750.1

Steller, *George William* [1709–1746] A sketch of Steller's life may be found in his "Beschreibung von dem Lande Kamtschatka," etc. Frankfort & Leipsic, 1774. (Steller, G. W. 1774.1.)

—— Observationes generales universam historiam piscium concernentes: de generatione piscium; de aetate truttacei generis; de usu appendicum intestinalium, etc. Novi Comment. Acad. Petropol., 1753, **3,** 405–420. Pre-Linn. 1753.1

Other works by Steller in vol. II, p. 494.

Steno, *or more properly* **Stenonis,** *Nicolaus* [1638–1686] For a short biography and list of writings, *see* Winter, J. G. 1916.1. For fuller biographies, *see* Plenkers, W. "Der Däne Niels Stensen, ein Lebensbild nach den Zeugnissen der Mit- und Nachwelt entworfen." Freiburg i. Br., 1884. Also Wichfeld, J. "Erindringer on den danske videnskabsmand Niels Stensen." Historisk Tiddskrift, Kjøbenhavn, 1865, 3. raekke, 4. bind, 1–109.

For a list of other biographies, *see* Winter, p. 202–203. For full details as to editions and reprints, *see* "Opera," 1910 ed. listed below.

—— De anatome rajæ epistola (In his De musculis et glandulis observationem specimen cum epistolis duabus anatomicis. Copenhagen, 1664. 4°.) Pre-Linn. 1664.1

This was in the form of a letter to Willem Piso. It also appeared in:

—— De musculis & glandulis observationum specimen cum duabus epistolis, quarum una ad Guil. Pisonem de anatome Rajæ; & alteram ad Paullum Barbette de vitelli in intestinis pulli transitu. Amstelædami, 1664. 12°. Pre-Linn. 1664.2

Other eds.: Florence, 1667, & Lugduni, 1683. These essays were reviewed in Phil. Trans. Roy. Soc. 1666, **1**, 176–178.

In this dissection, Steno discovered the spiral valve in the intestine and briefly described it, thus antedating the descriptions in Perrault, C., & in Anon. 743 & 769, this section.

—— Elementorum myologiæ specimen, seu musculi descriptio geometrica cui accedunt *Canis carchariæ* dissectum caput, et dissectus piscis ex Canum genere. Florentiniæ, 1667. 4°. Pre-Linn. 1667.1

Another issue, Amsterdam, 1669. This work also was reviewed in Phil. Trans. Roy. Soc., 1667, **2**, 627–628.

—— De solido intra solidum naturaliter contento dissertationis prodromis. Florentiæ, 1669. Pre-Linn. 1669.1

Contains various references to glossopetras, — fossil teeth of sharks and rays.

—— The prodromus to a dissertation concerning solids naturally contained within solids. London, 1671. xv, 112 p. pl. 8°. Pre-Linn. 1671.1

—— [Anatome *Cyprinis brevis*] Acta Med. Phil. Hafnien., 1673, **1**, 315–316. Pre-Linn. 1673.1

Figures (with an explanation) of a dissection made by Steno.

—— Ova viviparorum spectantes observationes. Acta Med. Phil. Hafnien., 1675, 219–232. Pre-Linn. 1675.1

Steno, *M.*

Galeus lævis (figure and description of spiral valve and oviduct), Spina piscis (figure spiral valve), Torpedo, & Argentine.

Also found in Le Clercq & Manget, "Bibliotheca Anatomica," I, 1685, and in "Coll. Acad. Part. Etrang.," Paris, 1757, **4**, 282–292.

—— De dentibus canis marini. Zodiacus Medico-Gallicus, 1682, **4**, 92. Pre-Linn. 1682.1

This title, from Boehmer, seems to be a fragment of 1667.1.

—— Extrait de la dissertation de N. Sténon sur les corps solides qui se trouvent contenus naturellement dans d'autres corps solides. Coll. Académique, (part. étrang.), 1757, **4**. Pre-Linn. 1757.1

A modern critical edition of the "Dissertation" is listed above under Winter, J. G. The complete scientific works of Steno with a brief biography have been issued by Vilhelm Maar under the title "Opera philosophica." 2 vols. Copenhagen, 1910. Copy, Col.

Stensen, *Nils. See* **Steno,** *N.*, the Latinized form of the name of the Danish physician.

Stephanus, *Carolus. See* **Estienne,** *Charles.*

Stobæus, *Johannes.* Dissertatio historica de cerauniis, betulisque lapidibus sub præsidio Kilæ Stobæi. Londini Gothorum, [Lund] 1738. pls. 4°. Pre-Linn. 1738.1

Glossopetras, p. 9–10.

Stobæus, (*or Stobée*) *Kilian* [1690–1742] Opuscula in quibus petrefactorum, numismatum et antiquitatum historia illustratur, in unum volumen collecta. Dantisci, 1752–53. 327 p. 17 pls. 4°. Pre-Linn. 1752.1

Contains *inter alia* J. Stobæus's "Dissertatio."

Stolze, —— (*respond.*) Dissertatio de ichthyocolla. Helmst., 1756. 28 p. 4°. Pre-Linn. 1756.1

Phil. Conr. Fabricius, *præses.*

Strabo [*c.* 63 B. C.—] Geographia. Venice, 1472. fol. Pre-Linn. 1472.1

1st ed. not known to us. There is a reputed ed., Rome, 1469. Other early eds.: Treviso, 1480; Venice, 1494 (2 issues), 1502, 1516; Geneva, 1587; Paris, 1620. Copies of early eds.: Prin., L. C., H., Cor.

Among the best later eds. are those of Coraes, Paris, 1805–19; Grosskurd, Berlin, 1831–34 (a monumental work); Kramer, Berlin, 1844–52; Müller, Paris, 1853; and Meineke, Leipzig, 1866–77. The first and best English version is that in 3 vols. by H. C. Hamilton, & W. Falconer, London, 1854–57 (reprinted 1889–1903). This contains a sketch of Strabo's life and critical notes on his work.

The following references apply to any ed.

Ichthyophagi: book II, chap. ii, § 3; chap. v, § 33 & 36; book XV, chap. ii, § 2 & 13; book XVI, chap. iv, § 4 & 13. Fishes of the Nile, book XVII, chap. i, § 40; chap. ii, § 4 & 5.

Stradanus, *Johannes* [1536–1605] Venationes ferarum, avium, piscium, pugnæ bestiarum, depictæ a Joanne Stradano; editæ a Philippo Gallæo, carmine illustratæ a C. Kiliano Dufflæo. Antwerpiæ, [1578]. 94 pls. obl. fol. Pre-Linn. 1578.1

"Many subsequent editions have appeared, the plates varying in number from 104 to 88. Some copies are entitled: "Venationis omne genus, aucupii piscatusque.'" — W. & S.

See also Visscher, C. J., this section.

Stradanus, Strada, or Straet was a Flemish-Italian painter who made the drawings reproduced herein.

Straet, *Jan van der. See* **Stradanus,** *Johannes.*

Suidas, —— [*fl. late in* 10*th cent.*] Concerning the man and his Lexicon *see* Daub, A. "De Suidas biographicorum origine et fide," 1880; and "Studien zu den Biographika des Suidas," 1882; also in Sandys, J. E. "History of classical scholarship," 1906, p. 407.

—— Lexicon græcum. Milan, 1499. fol. Pre-Linn. 1499.1

Editio princeps, translated by Demetrius Chalcondyles.

Copies: Y., N. Y. S., U. C., H. E. H.

Another and enlarged ed. is:

—— Lexicon, Gr. et Lat. edidit, indices adjecit Lud. Kusterus. 3 vols. Cantab. 1705. fol. Pre-Linn. 1705.1

Modern eds. are by T. Gaisford (1834), G. Bernhardy (1834–53), and most recent and valuable of all, by I. Bekker (1854).

Suidas, like Athenæus, wrote nothing on fishes himself, but has preserved to us data from other authors whose works are no longer extant and which but for him would be lost.

Sundius, *Peter.* Surinamensia grilliana. Holmiæ, 1748. 34 p. pl. Pre-Linn. 1748.1

Gymnotus, p. 26.

Also in Amœnitates Academicæ, 1749, **1**, 512; and in another ed., Erlangen, 1787. Copy, A. M. N. H.

Swammerdam, *Jan* [1637–1680] For life by H. Boerhaave, *see* in his edition of Swammerdam's "Biblia naturæ," Leyden, 1737, (Latin-Dutch); Leipsic, 1752 (German); and "Book of nature," London, 1758. For shorter sketches, *see* Locy, W. A. 1908.1 (p. 67–77, with portrait); and Miall, L. C. 1912.1 (p. 174–199).

—— Catalogus musei, exhibens curiosam suppellectilem variarum rerum exotic. t. natur. q. artefact., quas 50 annorum spatio collegit. Amstel., 1679. 143 p. 8°. Pre-Linn. 1679.1

Glossopetras & bufonites, p. 9; pisces, p. 30–34.

A catalogue of his father's collection, in Latin and Dutch in parallel columns.

Copy, N. Y. P.

Szent-Iványi, *Márton.* Curiosa et selectiora variarum scientiarum miscellanea. Decades tres in partes totidem subdivisæ. 3 vols. Tyrnaviæ, 1689–91. 4°. Pre-Linn. 1689.1

Decadis III. Pars I, continet dissertationes X et quidem de . . . piscibus, etc.

—— Dissertationes septem . . . IV. De piscibus. Tyrnaviæ, 1689. 2, 302 leaves. 4°. Pre-Linn. 1689.2

T

Tachard, *Guy* [–1694] Voyage de Siam des pères Jésuites envoyez par le roy au Indes & à la Chine. Paris, 1686. 424 p. Pre-Linn. 1686.1

Sharks, remoras, pilot-fish, bonitos and flying fish, p. 39–44.
Original ed. A Dutch version is:

—— Reis van Siam . . . gedaan door de vaders Jesuiten. Utrecht, 1687. iv, 196, 79 leaves. 4°. Pre-Linn. 1687.1

Another Dutch ed. with almost identical title, Amsterdam, 1687.

—— A relation of the voyage to Siam performed by six Jesuits sent by the French king to the Indies and China, in the year 1685. London, 1688. 298 p. Pre-Linn. 1688.1

Habits of sharks, remoras, and bonitos, 27–31. Fishes of the Cape of Good Hope, 66.
Reprinted in Arkstee & Merkus, Allg. Hist. Reisen, 1752, vol. XX.

Tappe, *David* [1649–] Fünfzehnen jährige curiose Ost-Indianische Reise-Beschreibung, so sich im Jahr Christi 1667 angefangen und im 1682 Jahre geendet hat. Hannover, 1704. 4°. Pre-Linn. 1704.1

Fishes, etc., 199–209.

Taverner, *John.* Certaine experiments concerning fish and fruite, practised by John Taverner, Gentleman, and by him published for the benefit of others. London, 1600. vi, 38 p. 4°. Pre-Linn. 1600.1

The experiments concern the construction of ponds, the treatment, breeding and feeding of fish therein, and the baits for and nature of pond fish.

Tavernier, *Jean Baptiste* [1605–1689] [On glue made by the Turks from body membranes of the sturgeon.] Phil. Trans. Roy. Soc. 1676, **11**, 714. Pre-Linn. 1676.1

An extract from a running review in the Phil. Trans. of Tavernier's voyages.

Tempesta, *Antonio* [1555–1630] Nuova raccolta degli animali piu curiosi del mondo, disegnati et intagliati da Antonio Tempesta. Roma, 1600. 4°. Pre-Linn. 1600.1

Another ed., Rome, 1650.

—— Venationes ferarum, avium, piscium, pugnæ bestiariorum; et mutuæ bestiarum delineatæ ab A. T. Romæ, 1602. obl. 4°. Pre-Linn. 1602.1

"Tempesta was a pupil of Stradanus, from whose work he seems to have borrowed the above title and the general idea of his compositions. They consist of 26 etchings in the edition of 1602 and 40 in that of 1627." — W. & S.
The edition of 1627 was printed by Visscher at Amsterdam and is generally listed under his name in bibliographies. *See* Visscher, C. J., this section.

Templer, *John.* [Method of catching carp in a pond with the hands.] Extract of a letter written by Mr. John Templer, June 16, 1673. Phil. Trans. Roy. Soc. 1673, **8**, 6066–6067. Pre-Linn. 1673.1

Theocritus [*fl. 3rd cent.* B. C.] Idyllia, quæ extant, cum vet. scholiis, cura Jo. Fell. Oxoniæ, 1678. 8°. Pre-Linn. 1678.1

Idyll xxi, lines 9–12, enumerates the fishing implements of the Syracusan fishermen.
The Idylls of Theocritus have been many times translated, edited, and republished. The most complete early editions are those listed below.

—— The idylliums of Theocritus, done into English . . . by Thomas Creech. London, 1681. 12°. Pre-Linn. 1681.1

Idyll xxi, "The fisherman," enumerates fishing implements used by two Syracusan fishermen; — "wicker baskets, rods, hooks, baits covered with seaweed, lines of horse hair, weels and wickerwork mazes, cords, and oars and an old boat on props."
Other English versions are: 1684, 1713, 1721, 1767, 1786, 1792, 1811. The best French translation is by Gail, Paris, 1808; the best German by J. H. Voss, Tübingen, 1808; & by Witter, Hildburghausen, 1819.

Theophrastus [*c.* 372–287 B. C.] For a sketch of his life, *see* Zeller, "Aristotle and the earlier peripatetics" (English translation by Costelloe & Muirhead, 1897). For a list of translations of his works into almost all European languages, *see* Baldwin's Dictionary of Philosophy and Psychology, vol. III, pt. i.

—— De piscibus in sicco viventibus. Venetiis, 1479. fol. Pre-Linn. 1479.1

Other eds.: Venice, 1497–98 (in "Opera" of Aristotle edited by Manutius); Paris, 1529;

Basel, 1550, 1552; Naples, 1655 (In "Antiperipatias" by Severinus, *q. v.*). The following title from Haller seems unknown to other bibliographers:

—— De piscibus, de singultu, de doloribus, de ebrietate, de sudore. 1495. Pre-Linn. 1495.1

Dissertation on ability of fishes to stand drought found also in "Opera," the first edition of which seems to be:

—— Opera omnia: Graece. Basiliæ, 1540. fol. Pre-Linn. 1540.1

Two other early eds.: Venice, 1552 and Lugduni Batavorum, 1613. Often re-issued. The best eds. are those by J. G. Schneider, Leipsic, 1821 (Latin); and by F. Wimmer, Paris, 1866 (Greek and Latin in parallel columns).

Theophrastus, a native of Eresus in the island of Lesbos, was the friend and successor of Aristotle, the guardian of his children, and the inheritor of his library.

Thévet, *F. André* [1502–1590] Les singularitez de la France antarctique, autrement nommée Amérique, & de plusieurs terres & isles decouvertes de nostre temps: . . . Paris & Anvers, 1558. 163 p. ills. sm. 8°. Pre-Linn. 1558.1

Contains first printed figures of Brazilian fishes.

Italian and English translations are:

—— Historia dell' India America, detta altramenta Francia antartica, tradotta . . . in Italiano da G. Horologgi. Venetia, 1561. 8°. Pre-Linn. 1561.1

—— The new found worlde, or Antarctike, wherein is contained wonderful and strange things, as well as . . . fishes . . . written in the French tong . . . and new translated into Englishe . . . etc. London, 1568. 140 leaves. Pre-Linn. 1568.1

Copies of this English version and of the original edition are in J. C. Brown library.

Other eds. are: Paris 1554 (doubtful); Venice, 1584 (Italian). A modern French ed. with notes by Paul Gaffarel, Paris, 1878.

—— Histoire générale des Indes occidentales et terres neuves. Paris, 1584. 8°. Pre-Linn. 1584.1

Not seen. Possibly a version of the above. Another ed., 1587.

Thiemen, *Johann Christoph.* Haus-Feld-Arzney-Koch-Kunst- und Wunderbuch . . . in zwanzig Abtheilungen enthalten, darinn folgende Sachen abgehandelt werden . . . xv. Von der Fischerey. . . Nürnberg, 1682. pls. 4°. Pre-Linn. 1682.1

"The 15th division contains directions for making, filling and emptying fish ponds; for stocking them, removing carp, making reservoirs and renovating old ponds; shows how to take fish with nets, traps, angles, night lines and the hands; and treats of the qualities of various fish as food and their uses in medicine, etc." — Westwood & Satchell p. 208.

Another ed., Nuremberg, 1685, 1587 p. 4°.

Thilo, *Gottfried (praeses).* Exercitatio de generatione piscium. Wittebergæ, 1667. 2 pls. 4°. Pre-Linn. 1667.1

Gottfried Baldwin, *respond.*

Thomas, *Gabriel* [*fl.* 17th cent.] An historical and geographical account of Pensylvania and West-New-Jersey. London, 1698. 8°. Pre-Linn. 1698.1

Gives a list of fishes found in the "Suskahanah" (Susquehanna) river.

—— Continuatio der Beschreibung der Landschaft Pennsylvanien, etc., darin die seltsamen Creaturen, Thiere, Vögel und Fische enthalten sind. Frankfurt & Leipzig, 1702. ii, 40 p. 8°. Pre-Linn. 1702.1

Modern reprints are: New York, 1848; Cleveland, 1903; and in "Narratives of early Pennsylvania and west New Jersey and Delaware 1630–1707," edited by Albert C. Myers. New York, 1912.

Thoresby, *Ralph* [1658–1725] Part of a letter from Mr. Ralph Thoresby, F.R.S. to the publisher, concerning several observables in his museum, near Leeds in Yorkshire. Phil. Trans. Roy. Soc. 1704. 23. 1070–1072. pl. vii. Pre-Linn. 1704.1

Brief description with figure (Tab. 7, fig. 1) of "the outward skin of the maw of a fish" from the Indies, p. 1070.

Tiburtius, *Tib.* Warum das Karpfenlaich in einigen Teichen nicht aufkomme, und wie dem abzuhelfen. Hannöv. Samml., 1757, 641. Pre-Linn. 1757.1

Other works in vol. II.

Titius, *J. D. (editor)* [1729–1796] Seltenheiten der Natur und Oeconomie, nebst deren kurzen Beschreibungen aus den Danziger Erfahrungen und Nachrichten, u.s.w. *See* Hanow, Michel Christoph. 1753.1, this section.

Torrubia, *P. Fr. Joseph* [c.1590–1768] Aparato para la historia natural española. Tomo primero. Contiene muchas dissertaciones physicas, especialmente sobre el diluvio. Resuelve el gran problema de la transmigracion de cuerpos marinos y su petrificacion en los mas altos montes de España, donde recientemente se han descubierto, etc., Madrid, 1754. xxiv, 204 p. 14 pls. fol. Pre-Linn. 1754.1

Fossil fishes, p. 11. Glossopetras españoles, p. 37–39, figs. Subterranean fishes of Mexico, p. 100. Fishes and the deluge p. 175, 192, and 198.

Tournefort, *Joseph Pitton de* [1656–1708] For biographical memoirs, *see* appendices to works cited below.

—— Relation d'un voyage du Levant . . . contenant l'histoire . . . de plusieurs isles de l'Archipel, de Constantinople, des côtes de la Mer Noire, de l'Arménie, de la Georgie, des frontières de Perse & de l'Asie Mineure . . . Enrichie . . . de plusieurs observations touchant l'histoire naturelle. ([To which is prefixed an] Eloge de M. de Tournefort. Par M. de Fontenelle) 2 vols. Paris, 1717. illust. 4°. Pre-Linn. 1717.1

"Poissons en usage chez les Grecs les jours de jeune; manière de pêcher en Naxie, en Provence, et au Trident."

Other eds. are: Amsterdam, 1717 (or 1718), 1737 (Dutch); Lyons, 1727; Nuremberg, 1776 (German). An English version is:

—— A voyage into the Levant [translated by J. Ozell] . . . To which is prefixed the author's life [by H. M. Lauthier]; as also his eulogium, pronounc'd by M. Fontanelle, etc. 2 vols. London. 1718. ills. 4°. Pre-Linn. 1718.1

Another English ed., 3 vols. London, 1741. 8°.

Tradescant, *John* (*the younger*) [1608–1662] Musæum Tradescantianum; or a collection of rarities, preserved at South-Lambeth neer London by John Tradescant. London, 1656. sm. 8°. Pre-Linn. 1656.1

"Divers sorts of strange fishes" (List of fishes from various countries), p. 8–9. Copy, H.

"The Tradescant was the first cabinet of natural curiosities formed in England. John Tradescant [senior], who is supposed to have died in 1638, bequeathed the collection to his son, who, in turn, left it to Elias Ashmole. These curiosities were therefore the nucleus of the Ashmolean Museum at Oxford." — Quaritch Cat. 1912.

Triewald, *Märten* [1691–1747] Rön huru iglar och fyrfotor kunna fördrifvas utur rude-dammar [Cyprinus]. K. Swensk. Vetensk. Acad. Handl., 1746, 216. Pre-Linn. 1746.1

—— Untersuchung wie Blut-Egeln und Eidechsen aus Karauschen-Teichen [Cyprinus] zu vertreiben sind. König. Schwed. Akad. Abhandl., 1746, 221. Pre-Linn. 1746.2

See note under Kästner, A. G., Pre-Linn.

[**Tristaon,** *Manuel*] A treatise of Brasil, written by a Portugal which had long lived there. (In Purchas his Pilgrims, 1625, vol. IV. lib. VII, cap. i, p. 1289–1320.) Pre-Linn. 1625.1

Section 6. Of the fishes that swim in the salt water.

Trivigiano, *Angelo* (*editor*). Libretto de tutta la navigatione de Re de Spagna. De le isole et terreni novamente trovati. [Translated and edited by Angelo Trivigiano]. Venesia. per Albertino Vercelle da Lisona, 1504, 16 leaves. 4°. Pre-Linn. 1504.1

This contains the first printed account of fishing with the remora. *See* also Martyr, P. 1504.1, this section.

Tull, *Samuel. See* **Watson,** *William*

Turnebus, *Adrianus* [1512–1565] Plinii libri II de piscibus cum scholiis Joh. Cæsarii. Venetiæ, 1518. 4°. Pre-Linn. 1518.1

Turner, —— (*Dr.*) [Letter mentioning some fifty English fishes] (Prefixed to Book IV of Conrad Gesner's "Historia Animalium," Frankfort ed. 1620.) Pre-Linn. 1620.1

Tyson, *Edward* [1650–1708] Embryonis *Galei lævis* anatome [in] Appendix ad historiam naturalem piscium. (In Willughby, F. De historia piscium. Oxonii, 1686. fol. ills.) p. 13–16. Pre-Linn. 1686.1

—— Lumpi Anglorum anatome [in] Appendix ad historiam naturalem piscium. (In Willughby, F. De historia piscium. Oxonii, 1686. fol. ills.) p. 25–27. Pre-Linn. 1686.2

—— Cuculus lævis cæruleo flavescens, cui in supremo capite branchiarum opercula. Or, the Yellow Gurnard [*Callionymus lyra*]. Phil. Trans. Roy. Soc. 1704 (1706), **24**, 1749–1753. pl. Pre-Linn. 1706.1

U

Uterverius, *Joannes Cornelius.* One of the group of the pupils of Ulisse Aldrovandi, to whom was confided by the senate of Bologna the work of collecting and editing the scattered manuscripts of the master.

V

Valentijn, *François* [1666–1725] Beschryving van oud- en nieuw Oost-Indien, vervattende een naauwkeurige en uitvoerige verhandeling van Nederlands mogentheyd in die gewesten, benevens eens wydluftige beschryvinge der Moluccos, Amboina, Banda, Timor en Solor, Java, en alle de Eylanden onder deselve landbestieringen behoorende; als ook der landdieren, vogelen, visschen, enz. enz. Met meer dan thein honderd en vyftig prentverbeeldingen verryckt. 5 vols. [in 10 parts.] Dordrecht & Amsterdam, 1724–26. 1050 pls. fol. Pre-Linn. 1724.1

Vol. III: Descriptions and figures of 528 fishes of Amboina, p. 330–515; Japanese gold and silver fish, p. 510; Fishing at Amboina, p. 15; at Banda, pt. II, p. 31. Vol. V: Fish of Ceylon, pt. I, p. 54; Salmon in Japan, pt. II, p. 71.

A 2nd & modern ed., The Hague, 1856–58. 3 vols. 8°. An extract from the original work is:

—— Poissons extra-ordinaires d'Amboine. (In Prévost, A. F. Histoire générale de voyages, etc. La Haye, 1747, **17**, 84–254. 485 figs.) Pre-Linn. 1747.1

—— Descriptio Amboiensis. III. De piscibus Amboiensis, etc.

This atlas of more than 50 plates of fishes, from the library of Albert C. L. Gunther, was presumably taken from the above work (1724–26).

This man, whose name is sometimes written Valentyn, was a Dutch Protestant missionary in Amboina. His book is the outcome of his travels and experiences in the East Indies, covering two periods, of nine and eight years each.

Valentini, *Michael Bernhard* [1657–1729] De virgine in sceleto funduli conspicua. Misc. Acad. Nat. Cur., 1697 — 1698 (1700), dec. 3, ann. 5 & 6, 96. Pre-Linn. 1700.1

—— Museum Museorum, oder vollständige Schau-Bühne aller Materialen und Specereyen, nebst deren natürlichen Beschreibung . . . aus andern Material- Kunst- und Naturalien- Kammern, Oost- und West-Indischen Reiss-Beschreibungen . . . verfasset und mit etlich hundert saubern Kupferstückern unter Augen geleget. 3 parts [in 1 vol.] Franckfurt-am-Mayn, 1704. xxii, 520; ii, 76; ii, 119 p. 16 pls. illust. fol. Pre-Linn. 1704.1

The half-title and the engraved title both read: "Valentini Natur- und Materialien-Kammer, auch Ost-Indianische Send-Schreiben und Rapporten."

Th. I, lapides bufonites and glossopetras, p. 63–66; fossil fish, p. 73–74. Th. III, sea horse, p. 469; fishes, p. 484–492: all figured and described.

2nd ed., Frankfort, 1714. The 3rd Theil (which contains the fishes), according to catalogue of British Museum (Natural History), was issued in separate and enlarged form in 1714 under the title listed below (1714.1).

—— Historia litteraria S. R. J. Academiæ Naturæ Curiosorum . . . &c. Gissæ, 1708. 4°. Pre-Linn. 1708.1

In nos. 36 & 37, Anguilla and Glossopetras are described.

—— Neu-aufgerichtetes Rüst- und Zeughaus der Natur . . . Dritten Theils des Musei Museorum, etc. Franckfurt-am-Mayn, 1714. vi, 226, 209, 24 p. 40 pls. text figs. fol. Pre-Linn. 1714.1

—— Amphitheatrum zootomicum, tabulis ænis quam plurimis exhibens historiam animalium anatomicam, etc. 2 parts. Frankfort & Gissæ, 1720. 262 p., appendix. 114 p. 105 pls. fol. Pre-Linn. 1720.1

This is merely a compilation of different anatomical memoirs, 18 of which are on fishes and are elsewhere listed under their authors. These are found in part II.

2nd ed. Frankfort, 1742. fol.

Valentyn, *Francis. See* **Valentijn,** *François.*

Valla, *Georgius* [1430–1499] De natura partium animalium, lacte, bile, carnibus, piscibus, etc. Argent., 1529. 8°. Pre-Linn. 1529.1

Vallisnieri, *Antonio* [1661–1730] For a sketch of his life, *see* Bibliothèque Italique, tome V, no. 3; also in Opera, 1733, below.

—— De ovario anguillarum. Ephemer. Acad. Nat. Cur. 1712, cent. 1 & 2, 153–165. fig. Pre-Linn. 1712.1

Vallisnieri, *A.*
—— Descriptio anatomica anguillæ (In Valentini, M. B. Amphitheatrum Zootomicum, 1720, pt. II, p. 126–131, pl.) Pre-Linn. 1720.1

—— Osservazioni di corpi marini che su monti si trovano; della loro origine, e dello stato del mondo avanti 'l diluvio, nel diluvio, e dopo il diluvio, lettere critiche. Venezia, 1721. 254 p. figs. 4°. Pre-Linn. 1721.1

Latin edition: "De corporibus marinis," etc. Venice, 1728.

—— Opere diverse. 3 vols. Venetia & Padua, 1721–26. 79 pls. 4°. Pre-Linn. 1721.2

Reproduction of eel, vol. II, p. 89.

—— Del Cameleonte e di vari animali d'Italia, [de locustis, ranis, crocodilo, remora, etc.] Giorn. Letter. Italia, [c. 1725], **23**, no. 2. Pre-Linn. 1725.1

—— Opere fisico-mediche stampate e manoscritte . . . raccolte da Antonio suo figliuolo, &c. (Notizie della vita, e degli studi del Kavalier A. Vallisneri, tratte dalle memorie da lui vivente affidata a G. Co: di Porzia, &c.) 3 vols. Venezia, 1733. illust. fol. Pre-Linn. 1733.1

Valvasor, *John Weichart* [1641–1693] A full and accurate description of the wonderful lake of Zirknitz in that country [of Carniola]. Phil. Trans. Roy. Soc., 1687 (1688), **16**, 411–426. Pre-Linn. 1688.1

Describes the fishing in this lake.

—— Die Ehre des Herzogthums Crain, mit Eklärungen und Anmerkungen. 4 parts. Leybach, 1689. fol. Pre-Linn. 1689.1

Some fishes are described.

Van der Stell, *Adrien.* Poissons, écrevisses et crabes de diverses couleurs et figures extraordinaires que l'on trouve autour des îles Moluques, et sur les côtes des terres Australes; publiés par L. Renard. 2 vols. Amsterdam, 1718–19. fol. Pre-Linn. 1719.1

Van der Stell's collections are figured in vol. II, 1719.
The 1st ed.; the 2nd Amsterdam, 1754.
See also, Renard, L. in this section, 1718.1.

Vanière, *Jacques* [1664–1739] Prædium rusticum. Tolosæ [Toulouse], 1730. 12°. Pre-Linn. 1730.1

Fishes in canto XV; vivarium, canto XVI.
Other eds.: Tolosa, 1742; Paris, 1746; Amsterdam, 1749; Cologne, 1750; Paris, 1765 & 1780 (*See* in Vol. II. Vanière, J. 1765.1 & 1780.1); Paris, 1786.
For a late English version, *see* in Vol. II Vanière, J., 1809.1.

Varro, *Marcus Terentius* [c. 114–26 B. C.] De re rustica libri tres. (Included in Scriptores rei rusticæ. Venetiæ, 1472. fol.) Pre-Linn. 1472.1

Books II and III relate to fishes. In chap. 17 of the latter are described the famous great salt water ponds or pounds of the Rome of Varro's day.
For various eds. of this compilation, *see* under Anon. in this section. One of the best is:

M. T. Varronis de re rustica libri III. (In Gesner, J. M. Scriptores rei rusticæ veteres latini, etc. 1787, vol. I. 8°.)

A well-known English version is:

The three books of M. Terentius Varro concerning agriculture. Translated by the Rev. T. Owen, M. A. Oxford, University Press, 1800. 8°.

"There are German translations by G. Grosse, Halle, 1787–8, and by J. F. Mayer, Nürnberg, 1774 & 1781. In Panckoucke's 'Bibliothèque Latine-Française,' 1826, there is a French version by X. Rousselot accompanying the original; and another by F. Wolff in Nisard's 'Collection des auteurs Latins,' etc. 1850." — W. & S.

—— Varronis opera omnia quæ extant. Cum notis J. Scaligeri, A. Turnebi, P. Victorii, & A. Augustini. His accedunt tabulæ naufragii, seu fragmenta ejusdem, etc. 6 parts. Durdrechti, 1619. 8°. Pre-Linn. 1619.1

Other eds. of the "Opera" are Augsburg; 1581, 1601 (said to be very accurate), & 1619.

Varro, *Marcus Terentius,* **Cato,** *M.,* **& others.** Libri de re rustica. Parisiis, 1533. 506 p. fol. Pre-Linn. 1533.1

Other eds.: Paris, 1543; Lugduni, 1549; Leipsic, 1794–95.
See also Cato, M., Varro, M. T., & others, Pre-Linn. 1533.1.

Velius, *Th.* Chronyk van Hoorn, etc. Hoorn, 1740. Pre-Linn. 1740.1

Deals extensively with herring fisheries.
Other eds.: Hoorn, 1604, 1617, 1648.

Venables (*Col.*) *Robert* [c. 1612–1687] The experienc'd angler, or, angling improv'd; being a general discourse of angling, imparting many of the aptest wayes and choicest experiments for the taking of most sorts of fish in pond or river. London, 1662. xvi, 105, vi p. pls. Pre-Linn. 1662.1

"The engravings of fish are the same as those in [the first four editions of] Walton's "Compleat angler." — W. & S.
Other eds.: 1666, 1683, 1686; and a 6th, in 1825–1827. The 2nd edition was destroyed in the great fire, 1666.
The London reprints of 1825 and 1827 both contain a memoir of Venables. The latter is the better.

Venegas, *Miguel* [1680–1764]

See in vol. II, p. 580, 1757.1 & 1759.1.

Venzky, *G.* Von den Fischen Steinpietschen, als lebendigen Wetter-Zeigern. Hamburg. Ber. Gelehrt. Sachen, 1740, 485. Pre-Linn. 1740.1

Villeneuve, —— [On the organ of hearing in the sea horse] Mercure de France, June, 1756. Pre-Linn. 1756.1

Walbaum says that this appeared in French at Amsterdam, 1752. *See* also Villeneuve, Add. 1760.1.

Vincent, *Levinus.* Het tweede deel of vervolg van het wondertooneel der nature, ofte een korte beschryvinge zo van bloedelooze, zwemmende, vliegende, kruipende, en viervoetige geklaauwde eijerleggende dieren, als van hoornen, sculpen, koraalen, zee-heesters, metallyke en in steen veranderte dingen etc. Van de welke een zeer groote meenigte word bevat in de kabinetten van, etc. Amsterdam, 1715. 278 p. 7 pls. 4°. Pre-Linn. 1715.1

Fishes, p. 65–104. Copy, H.

This is the 2nd vol. of his "Wondertoneel der Nature," etc. The 1st (43 p.), Amsterdam, 1706, contains no fishes. Other versions follow. These not seen and not known to contain fishes.

—— Catalogus & descriptio animalium, volatilium, reptilium & aquatilium ut & animalium quadrupedum tam oviparorum quam viviparorum aliorumque creaturarum rarisissimarum ex mundi plagis, etc. La Haye, 1726. 4°. Pre-Linn. 1726.1

Latin and French are in parallel columns.

Abstract in Abh. K. Akad. Wiss., Berlin, 6, 31.

Catalogus van eene uitmiontende fraaje verzameling van viervoitigen, vligenden &c. aieren, zeecorallen &c. Zunde alles, meerendels het van L. Vincent gekocht en nu onlangs nagelaaten door P. Bout. Hage, 1779. 8°.

Vincentius Bellovacensis (*Vincent de Beauvais,* or *Vincent of Burgundy*). [*c.* 1190–1264] For a brief sketch of the life of *the* encyclopædist of the middle ages, and for a short analysis of his works, *see* article by T. A. Archer in Encyclopædia Britannica, 1911, 11th ed., vol. XXVIII, p. 90–91. Also J. B. Bourgeat, "Études sur Vincent de Beauvais, théologien, philosophe, encyclopédiste." Paris, 1856; and Ferguson, "Account of the first edition of the 'Speculum majus' ['Speculum naturale'] 1473." Trans. Arch. Soc., Glasgow, 1844. Also Vogel, Aloys. 1843.1.

—— Incipit speculum naturale Vincentii beluacensz fratris ordinis predicatorum. Strasburg, 1473. fol. Pre-Linn. 1473.1

Editio rarissima. Thought to be the 1st ed., though there is said to be one *c.* 1468–70.

Fishes, book XVII.

—— Speculum maius, quod alia specula complectitur, naturale, doctrinale, morale, historiale. 7 pts. Argentinæ, 1473–1476. fol. Pre-Linn. 1473.2

The first ed. of the "Speculum majus" of Vincent, consisting of the 4 books, and containing all known of natural history in his day, and in fact of all knowledge at that time. It passed through many eds. of which the rarest are: Venice, 1483 (Speculum naturale only); 1493 & 1494 (all 4 Specula); Nuremberg, 1483, 1486, 1493. Later eds. are Venice, 1591, & Lyons, 1591. There is an ed. without date entitled:

—— Bibliotheca mundi sive speculum majus. [Basiliæ?]

According to Cuvier, the best ed. is:

—— Speculum quadruplex, naturale, doctrinale, morale, historiale, in quo totius naturæ historia; omnium scientiarum encyclopædia . . . Omnia nunc accurate recognita et distincte ordinata . . . studio Theologorum Benedictinorum . . . in Academia Duacensi. 4 vols. Duaci, 1624. fol. Pre-Linn. 1624.1

"Speculi naturalis seu tomi primi liber XVII agit de piscibus quæ ad eos referuntur."

"Speculi doctrinalis seu tomi secundi, liber XV præter alia agit de piscibus."

Copies of early eds. in H., N. Y. P., L. C., H. E. H., Stan.

Visscher, *Claes Janss.* [1580–] Venationes ferarum, avium, piscium, pugnæ bestiariorum et mutuæ bestiarum delinatæ ab Antonio Tempesta t'Amsterdam gedruckt bÿ Claes Janss. Visscher anno 1627. Amsterdam, 1627. 104 pls. Pre-Linn. 1627.1

Plates only; no text.

See note under Stradanus, J., this section.

—— Libellus varia genera piscium complectens. [Amsterdam, *c.* 1630]. Pre-Linn. 1630.1

Consists of plates drawn by Nicolas de Bruyn.

Visscher, *Nic. J.* Piscium vivæ icones, inventæ ab Andr. Collardo et excusæ a N. J. Visscher. Amsterdam, 1634. fol. Pre-Linn. 1634.1

Twenty-six plates, without descriptions. *See* also Collart, A., Pre-Linn., 1634.1.

—— Delineationes vivæ animalium. Amstelodami, 1659. 4°. Pre-Linn. 1659.1

A number of fishes are figured.

It seems not improbable that the foregoing plates of fishes were engraved and printed by the man whose full name was Claes or Nicolaes Janszoon Visscher.

Vlaming, *Corneille de.* Zee-Tooneel. [*c.* 1715] Pre-Linn. 1715.1

Vlaming was an official of the Dutch East Indies Co. in Bengal. His figures of oriental

Vlaming, *C.*
fishes, drawn under his care and inspection, probably by a native artist, served as the source of the figures in the first part of Renard's fishes of India. *See* note under Renard, L., this section, 1718.1. Vlaming's original drawings are, or were, in Muséum d'Histoire Naturelle, Paris.

Vogelhaupt, *Jo.* Progr. Strena, quæ sistit septem pisces, sive tot aquatilia maxime virtuosa. Anæmontæ, 1670. 4°. Pre-Linn. 1670.1

Voigt, *M. Gottfried* [1644–1682] For a memoir of his life, *see* Nouv. Liter. German. Hamburg, 1708, 438.

—— (*præses*) Dissertatio de piscibus fossilibus atque volatilibus. Wittebergæ, 1667. 16 p. 4°. Pre-Linn. 1667.1

Johannes Heinrich Vulpius, *respond.*

—— Deliciæ physicæ de stillicidis sanguinis, lacrimis crocodili, catulis ursorum, piscibus fossilibus et volatilibus, etc. Rostock, 1671. 8°. Pre-Linn. 1671.1

Review in Phil. Trans. Roy. Soc., 1671, **6**, 3017–3018.

—— Beantwortung der Frage: Schlafen auch die Fische? (In his Neu Vermehrten Phys. Zeitvertreibe., Stettin, 1721, 611 p. 12°.) Pre-Linn. 1721.1

Volckhart, *Johannes.* (*respond.*) Dissertatio juridica de jure piscandi. Jenæ, 1671. 4°. Pre-Linn. 1671.1

J. V. Beckmann, *præses.*

Vorstius, *D. Conr.* [1569–1622] De piscatione amica collatio. 1613. 4°. Pre-Linn. 1613.1

Vosmaer, *Arnout* [1720–1799] Poissons, écrevisses et crabes . . . que l'on trouve autour des isles Moluques, et sur les côtes des Terres Australes . . . 2. édition augmentée d'une préface par . . . A. Vosmaer. 2 vols. [in 1] 1754. illust. fol. Pre-Linn. 1754.1

See also Renard, L., Pre-Linn., 1718.1.

Vulpius, *Johannes Henricus* (*respond.*) Ex historia naturali disputationem publicam de piscibus fossilibus atque volatilibus . . . Wittebergæ, 1667. 16 p. 4°. Pre-Linn. 1667.1

M. G. Voigt, *præses.*

W

Wafer, *Lionel* [*c.* 1640—*c.* 1700] A new voyage and description of the Isthmus of America. London, 1696. 224 p. Pre-Linn. 1696.1

Fishes, p. 124–129, Indians fishing with nets and hands, p. 129–130.

The 1st ed.; 2nd & 3rd are, London, 1699 & 1704. French versions: Amsterdam, 1705; Paris, 1706. There are also German and Swedish translations. Wafer's voyage is also found as:

—— A new voyage and description of the Isthmus of America. Giving an account of the author's abode there, the form and make of the country . . . To which are added, the natural history of those parts, by a Fellow of the Royal Society. (In A collection of voyages, etc. London, 1729, vol. III.) Pre-Linn. 1729.1

"An additional account of several beasts, birds, fishes, reptiles, &c. communicated by a member of the Royal Society," chap. II.

Wagner, *Gottfried Jacob.* Der in der edlen Fischerey wohlunterrichtende und erfahrne Fischer, welcher lehret, wie man soll die Teiche anlegen, bauen, warten, etc. Nürnberg, 1729. viii, 261 p. 13 pls. 8°. Pre-Linn. 1729.1

Other eds.: Nuremberg, 1730, 1739; Breslau, 1758, 1762; Vienna, 1785. The 1762 ed. bears title:

Der vollkommene Fischer, welcher zeiget wie man die Teiche anlegen, bauen, etc. Breslau, 1762. vii, 191 p. 8°.

Waldschmid, *Wilhelm Ulrich* [1669–1731] Lampetræ fluviatilis anatome. Ephemer. Acad. Nat. Cur., 1697–98 (1700), dec. 3, ann. 5 & 6, 545–547. Pre-Linn. 1700.1

Included also in the "Amphitheatrum zootomicum" of M. B. Valentini, 1720. pt. II, p. 131.

Wallace, *James* (*M. A.*) [–1688] Description of the islands of Orkney. Edinburgh, 1693. pls. map. 16°. Pre-Linn. 1693.1

Contains accounts of the fishes.

Another ed., with additions by the author's son (James Wallace, M.D.), was published in 1700, and in 1863 the whole was edited and reprinted by J. Small. *See* Small, J., 1863.1.

Walton, *Izaak* [1593–1683] For biographies, *see* Marston, R. B. 1894.1; Westwood, T. 1884.1; Zouch, T. 1790.1. For a chronological list of editions of "The compleat angler," 1593–1893, *see* Anon. 272, which should be credited to D. B. Fearing. Also notes below.

—— The compleat angler or the contemplative man's recreation. Being a discourse of fish and fishing, not unworthy the perusal of most anglers, etc. London, 1653. xvi, 246 p. 8°. Pre-Linn. 1653.1

The *editio princeps* of this famous work which has been reproduced many times and in many forms. Westwood & Satchell in the body of their work list 7 Pre-Linnæan and 79 Post-Linnæan eds. prior to 1882, on all of which they give some notes. These eds. they have either examined or have definite records of. On p. 369–370, they give a "skeleton chronicle" of 7 Pre- and 83 Post-Linnæan eds. to 1882, giving place, publisher, editor (where possible) and pages for each edition. Lists of eds. of the work of the "Father of Angling" are also found in the catalogue of the Bartlett collection. The Hecksher sale catalogue lists 171 items of the "Compleat Angler" and gives collations, and in addition lists 71 items of Waltoniana.

Cotton's name first appears in one of the 1676 eds. which is entitled as follows:

—— The universal angler, made so, by three books of fishing. The first by Mr. Izaak Walton; the second by Charles Cotton Esq.; the third by Col. Robert Venables. All which may be bound together, or sold each of them severally. London, 1676. 8°. Pre-Linn. 1676.1

This is the fifth and last ed. published during Walton's lifetime. The next bears date 1750 and is entitled:

—— The compleat angler; or, contemplative man's recreation. In two parts. Containing I. A large and particular account of rivers, fish-ponds, fish and fishing: written by the ingenious and celebrated Mr. Isaac Walton. II. The best and fullest instructions how to angle for a trout and grayling in a clear stream. By Charles Cotton, Esq. London, 1750. 12°. Pre-Linn. 1750.1

Notable reprints are those of 1808, 1824, 1825, 1836, 1844 & 1881. For notes on these, *see* Westwood & Satchell. In 1888, Marston brought out his superb "Lea & Dove" ed., it being the hundredth ed. of the "Compleat Angler." Probably the best American reprint is the 2-volume ed. issued at Boston in 1889.

The only translation into a foreign tongue known to us is:

Walton, *I.*

Der vollkommene Angler von Isaac Walton und Charles Cotton, herausgegeben von Ephemera, übersetzt von I. F. Schumacher. Hamburgh, 1859. xii, 308 p. 10 pls. 8°.

Walton is said to have taken his idea of the angler from Nicholas Breton's "Wit's-Frenchman." 1597. (*q. v.*)

Walton, *I.*, & **Cotton,** *C.* *See* **Walton,** *I*, 1676.1; and **Cotton,** *C.* 1676.1

Wardenburg, *C. Th.* Dissertatio quaedam circa jus piscatus. Lugduni-Batavorum, 1757. 4°. Pre-Linn. 1757.1

Warren, *G.* An impartial description of Surinam upon the continent of Guiana in America. With a history of several strange beasts, birds, fishes, serpents, etc. London, 1667. 28 p. 4°. Pre-Linn. 1667.1

Mentions swordfish and electric eel.

Watson, *Frederic.* The animal-world displayed, or the nature, and qualities of living creatures described under the denominations of birds, beasts, fishes and serpents, etc. London, 1754. pl. 8°. Pre-Linn. 1754.1

A Dutch version is:

De dierlyke wereld ter beschonwinge opengezet. Uit het Engl. mit merklijke verbeteringen en aanterkeningen door C. Nozeman. Amsterdam, 1761. ills. 8°.

Watson, *William* [1715–1787] An account of Mr. Samuel Tull's method of castrating fish. Phil. Trans. Roy. Soc. 1754 (1755), **48**, pt. 2, 870–874. Pre-Linn. 1755.1

This account excited great interest and was much copied or abstracted. *See* Gentleman's Mag. Hist. Chron. [Urban's], **21**, 410. *Ibid.*, **25**, 416. — London Mag., **24**, 422. — Uitgez. Verh., 1757, **1**, 389. Abstract in Comment. Lipsiens., **5**, 595. — Mag. Anglais, 1765, (Jan.), art. 4. — Physikal. Oecon. Patriot., 1. Th., 337. — Hannover Mag., 1765, 589. — Phys.-Belustig., Berlin, 1755. — Comm. de Rebus, **5**, 595. — Schauplatz Kunst Handw., 13. Th., 72.

Wecker, *John.* 18 books of the secrets of nature and art. First designed by John Wecker . . . augmented and enlarged by Dr. R. Read. London. 1660. fol. Pre-Linn. 1660.1

Book VII, pp. 134–8, "Secrets of fish and fishing."

Wedel, *George Wolfgang* [1645–1721] De *Trutta saxatilis.* Ephemer. Acad. Nat. Cur., 1673–74 (1688), 1. dec., ann. 4 & 5, 74–76. Pre-Linn. 1688.1

Weickmann, *Christoph.* Verzeichniss unterschiedlicher Thiere, Vögel, Fische, Meergewächse, Erz- und Bergarten, edlen und andern Steinen. Ulm, 1655. 8°. Pre-Linn. 1655.1

1st ed. not known. Later ones with slightly varying titles are:

—— Exoticophylacium Weickmannianum, oder Verzeichniss unterschiedlicher Vögel, Thier, Fisch, Gewächs, Erz- und Bergarten, so in C. Weickmanns Kunst- und Natural-Cammer in Ulm zu sehen. Ulm, 1659. 12°. Pre-Linn. 1659.1

—— Exoticophylacium Weickmannianum. Oder: Verzeichnuss unterschiedlicher Thier, Vögel, Fisch, Meer-Gewächs, Ertz- und Berg-Arten, &c. so in der Kunst- und Natural-Kammer des weyland Herrn Christoph Weickmanns . . . zu finden. 1741. 77 p. 2 pls. 8°. Pre-Linn. 1741.1

Werlosching, *Johann Baptist.* De mirabile piscatione in certo Styriæ lacu, post certam piscium quantitatem captam tempestatem inducens. Misc. Acad. Nat. Cur. 1701 — 1705, dec. 3, ann. 9 & 10, 42. Pre-Linn. 1701.1

—— De exstruendis piscinis. (In Ellis, William. Modern Husbandman, 1750, p. 59.) Pre-Linn. 1750.1

German translation, Allgem. Magazin, pt. II, 44. — Dresdner Gel. Anz., 1757, 709.

Westbeck, *Zacharias.* Beschreibung der Sköt-Spiggs-Fischerey, und wie aus diesen Fische ein Oehl gesotten wird. König. Schwed. Akad. Abhandl., 1754, **15**, 265. Pre-Linn. 1754.1

See note under Kästner, A. G., this section.

—— Beskrifning pä sköt-spiggs-fisket, och huru olia kokas af denna fisk. K. Swensk. Vetensk. Acad. Handl., 1754, **15**, 261–266. Pre-Linn. 1754.2

Refers to *Gasterosteus aculeatus.*

Westphalus, *J. C.* Piscinæ publicæ Lissensi prope delitium supernatante. Nouv. Liter. German. Hamburg, 1705, 103. Pre-Linn. 1705.1

Whitbourne, *Richard* [*fl.* 1579–1627] A discourse and discovery of Newfoundland with many reasons to proove how worthy and beneficiall a plantation may there be made, after a far better manner than now it is, etc. London, 1622. 107, 15 p. sm. 4°. Pre-Linn. 1622.1

Reference to cod-fishing (p. 11–13) as carried on by the Basques in 1615.

A modern version is:

Westward Hoe for Avelon in the Newfoundland, as described by Capt. Richard Whitbourne of Exmouth, Devon. 1622. Edited and illustrated by T. Whitburn. London, 1870. 8°.

Williams, (*Captain*) *Griffith.* An account of the Island of Newfoundland, its trade and fishery. 1705. 35 p. 8°. Pre-Linn. 1705.1

Williams, *Roger* [*c.* 1604–1684] A key into the language of America, or an help to the language of the natives in New England. London, 1643. Pre-Linn. 1643.1

List of Indian names for food fishes, and their English equivalents.

Reprinted in Coll. Rhode Island Hist. Soc., 1827, **1**. Also in Rept. U. S. Fish Comm. 1871–72 (1873), 164–165. Comment on the above list, by J. Hammond Trumbull. Rept. U. S. Fish Comm. 1871–72 (1873), 165–169.

Williamson, *John* (*angler*). The British angler . . . comprehending . . . an exact description of the several kinds of fish that are found in the rivers and on the sea coasts of Great Britain, etc. London, 1740. vii, 318 p. illust. 3 pls. 12°. Pre-Linn. 1740.1

Willisch, *Chr. Gottfried.* De Jona in pisce. Leipzig, 1721. 4°. Pre-Linn. 1721.1

Another ed., Altenburg, 1732.

Willius, *Johannes Valentinus.* De aculeo piscis Fösing [Trachinus] observatio. Acta Med. Phil. Hafn., 1674–76 (1677), **3**, 154–157. Pre-Linn. 1677.1

Willughby, *Francis* [1635–1672] For a memoir, *see* Jardine, (Sir) William, in his Naturalist's Library, vol. XXXVI, edition of 1843; vol. V, issue of 1845–46.

—— Francisci Willoughby Ichthyographia ad amplissimum virum Dnum. Samuelem Pepys, Præsidium Soc. Reg. Londinensis, Concilium, et Socios ejusdem. Figuræ novæ, quæ non paucæ sunt notantur. Sumptibus Societatibus Regalis. Londinensis, 1685. fol. Pre-Linn. 1685.1

Copy of the special engraved title-page to the plates of Willughby's great work. It is dated and the plates were presumably published in 1685, one year earlier than the text. This is often cited as a separate work and is so listed.

—— Historia piscium libri quatuor . . . In quibus non tantum de piscibus in genere agitur, sed & species omnes, tum ab aliis traditæ, tum novæ & nondum editæ bene multæ, naturæ ductum servante methodo dispositæ accurate describuntur. Earumque effigies, quotquot haberi potuere, vel ad vivum delineatæ, vel ad optima exemplaria impressa; . . . Cum appendice historias & observationes in supplementum operis collatis complectente. Totum opus recognovit, coaptavit, supplevit, librum etiam primum & secundum integros adjecit Johannes Raius. Oxonii, 1686. 343, 30 p. 186 pls. fol. Pre-Linn. 1686.1

Dedicated to Samuel Pepys, and published at the expense of Bishop Fell and the Royal Society, of which the author and his friend and editor, John Ray, were among the original fellows.

Reviewed anonymously in Phil. Trans. Roy. Soc., 1686, **15**, 1301–1308.

2nd ed., London, 1743. fol.

One hundred years later the plates in the above were reproduced as follows:

I (–X) Tabula . . . Pisces ex Raii emendata ichthyologia Willughbeii forma minori descripti, etc. Augusta Vindelicorum [Augsburg], 1786. obl. fol.

"The engraved title-page to the plates of Willughby's Historia Piscium is reproduced in miniature with the legend altered to read 'F. Willughbeii Ichthyographia. Totum opus recognovit, coaptavit, supplevit J. Ray . . . 1686. Nunc forma effigies edidit negotium Acad. Caesareo Francisce cum gratia et privilegio. S. C. Mey. Aug. Vind. A.D. 1786.'"

Title and note from catalogue of British Museum (Natural History).

—— Appendix ad historiam naturalem piscium. (In his De historia piscium libri quatuor, etc. Oxonii, 1686. fol.) 30 p. Pre-Linn. 1686.2

i. Pisces Indiæ orientalis a Joanne Nieuhofs descripti.

ii. Pisces sequentes adjecit D. Martinus Lister.

iii. [Short notes from Ray, Tyson, & Robinson].

All these are listed elsewhere under these authors, as is the "Index piscium" of Cromwell Mortimer.

"Willughby was the most accomplished zoologist of this or any other country, for all the honour that has been given to Ray, as far as it concerns systematic zoology, belongs exclusively to him. He alone is the author of that system which both Ray and Linnæus took for their guide, which was not improved by the former or confessed by the latter." Swainson.

Winkelmann, *Hans* [*Johann*] *Just.* [1620–1699] Der amerikanischen neuen Welt Beschreibung, darinnen deren Erfindung, Lage, Thiere, Vogel, Fische, etc. Oldenburg, 1664. figs. 4°. Pre-Linn. 1664.1

Dutch version, Amsterdam, 1667.

Winslow, *Jacques Bénigne* [1669–1760] Remarques et éclaircissements, par l'anatomie comparée, sur plusieurs articles de la 2de partie du traité de Borelli, de motu animalium. Mém. Acad. Sci. Paris, 1738, 65–96. Pre-Linn. 1738.1

See Borelli, G. A., Pre-Linn. 1680.1.

Wolfart, *Peter* [1675–1726] Historiæ naturalis Hassiæ inferioris pars prima qua potiora et elegantiora hujus fossilia, figurata æque ac certa quandam et regulari figura carentia, etc. Der Natur-Geschichte des Nieder-Fuerstenthums Hessen. Erster Theil. Cassel, 1719. 52 p. 26 pls. fol., Pre-Linn. 1719.1

Various fossil fishes figured & described. Text in both Latin and German.

Wonnecken (*Dr.*) *Johann.* *See* **Cube,** *Johannes von.*

Wood, *William* [1580–1639] New England's prospect. A true, lively and experimentall description of that part of America, commonly called New England: discovering the state of that countrie both as it stands to our new-come English planters and to the old native inhabitants. London, 1634. Pre-Linn. 1634.1

Refers to cod, salmon and mackerel fisheries of New England, also fishes of the Merrimac and Charles rivers, Mass.

Other eds.: 1635, 1639, London; & 1764, Boston. Reprinted in Publs. Prince Soc. Boston, 1865. Extract in Rept. U. S. Fish Comm. 1871–72 (1873), 161–162.

Woodward, *John* [1665–1728] Fossils of all kinds, digested into a method suitable to their mutual relation and affinity, etc. London, 1728. 56, 131 p. Pre-Linn. 1728.1

Glossopetras, bufonites, etc., p. 13–19.

—— A catalogue of the additional English fossils in the collection of J. Woodward, M.D. London, 1728. Pre-Linn. 1728.2

Partes piscium, p. 52–53.

Also in "Foreign Fossils," p. 20–29 (which is a separately paged part of the above).

This forms vol. II of the following work, but is paged separately and is pre-dated.

—— Attempt towards a natural history of the fossils of England (In a Catalogue of the English fossils in collection of J. Woodward, etc. 2 vols. in 1. 1729. sm. 8°.) Pre-Linn. 1729.1

Vol. I, pt. II, A catalogue of English fossils in the collection of John Woodward. — Piscium partes, p. 82–86.

Vol. II, pt. II, A catalogue of the foreign fossils in the collection of John Woodward. — Pisces eorumque partes, p. 20–29.

Woodward's book seems to have been printed in parts, some dated and some not, but each part paged separately.

Copy, N. Y. P.

W[orlidge], *John* [*fl.* 1669–1698] Systema agriculturæ, . . . To which is added, kalendarium rusticum; or the husbandmans monethly directions . . . and dictionarium rusticum: or, the interpretation of rustick terms. London, 1669. xxviii, 278 p. illust. 4°. Pre-Linn. 1669.1

Fishing, chap. XII.

Other eds., London, 1675, 1681, 1687, 1688, 1697, 1699, etc.

"Of fishing and fowling," p. 250–259, (1675 ed.).

Worm, *Ole* [1588–1654] Museum Wormianum. Seu historia rerum rariorum, tam naturalium quam artificialium, tam domesticarum, quam exoticarum, quæ Hafniæ Danorum in ædibus authoris servantur, etc. Variis & accuratis iconibus illustrata. Lugduni Batavorum, 1655. x, 388 p. illust. fol. Pre-Linn. 1655.1

Fishes, p. 265–278, chaps. 10–15, book III.

—— De piscibus nonnullis lucentibus. (In Bartholini, Th. Epistolarum Medicinalium. 1663. cent. 1, ep. 28, 118.) Pre-Linn. 1663.1

Another ed., The Hague, 1740.

—— Dissertatio de glossopetris. Hafniæ, 1686. 27 p. 4°. Pre-Linn. 1686.1

Wotton, *Edward* [1492–1555] De differentiis animalium libri x, etc. Lutetia Parisiorum [Paris], 1552. 220 p. fol. Pre-Linn. 1552.1

The external and internal characters of fishes, methods of reproduction, etc., book VIII, p. 136–173.

Abstract in Isis, 1833, 1173–1182.

"Wotton methodised the zoology of Aristotle, and drew up the first formal classification of animals. His book is sagacious and careful, but dry." Miall, 1912.1.

Wren, *Christopher* [1675–1747] [The reproduction of eels] (In Birch, Thomas, History of the Royal Society in London. 4 vols. London, 1756. vol. III, p. 350.) Pre-Linn. 1756.1

Wright, *W.* The complete fisher: or, the true art of angling, by W. Wright, and other experienc'd anglers. London, 1740. 12°. Pre-Linn. 1740.1

X

Xenocrates [396–314 B. C.] Xenocratis de alimento ex aquatilibus animantium libellus, Græce nunc primum editus, imperfectus. Idem Latine perfectior, J. B. Rasario . . . interprete. Accedunt C. Gesneri scholia, in ea Xenocratis que Grece his camus, etc. (In Dubravius, J. J. Dubravii . . . de piscinis et piscium qui in eis aliuntur naturis libri quinque. 1559. 4°.) Pre-Linn. 1559.1

References to numerous fishes used as food.

Copy in library A. M. N. H., in both Latin and Greek, in 57 unnumbered pages, bound in same volume with, but forming a distinct unit apart from, the "De piscinis et piscium" of Dubravius. Found also in J. A. Fabricius "Biblioth. Græca," Hamburg, 1720, vol. IX. Another and excellent edition is by J. G. F. Frantzius. Frankfort & Leipsic, 1779.

Ximines, *Francisco* (*editor*). *See* **Hernandez,** *Francisco*, this section.

Y

Ysbrant, *E.* Drie-jahrige Reize naar China. Amsterdam, 1704. 4°. Pre-Linn. 1704.1

Not seen. Title from Agassiz.

Z

Zanardus, *Michael.* Disputationes de universo elementari in tres partes divisæ . . . In tertia de meteoris, & in his inter cetera de melle & manna, signis pestilentiæ, de aquis & piscibus, de metallis, lapidibus, plantis, serpentibus, quadrupedibus aliisque. Venetiis, 1619. 4°. Pre-Linn. 1619.1

Other eds.: Coloniæ, & Francofurti, 1620.

Zannichelli, *Giovanni Jacopo* [1622–1729] Apparatus rariorum musæi Zannichelli. Venice, 1720. Pre-Linn. 1720.1

Some Monte Bolca fishes listed.

—— Enumerato rerum naturalium quæ in Museo Zannicheliano asservantur. Venetiis, 1736. 132 p. 4°. Pre-Linn. 1736.1

Some fossil fishes are described.

Zeidler, *Melchior* (*præses*) [1630–1686] Exercitatio physica de respiratione piscium, quam statuunt nonnulli. Jenæ, 1656. 4°. Pre-Linn. 1656.1

Fab. Bernhardi, *respond.*

Zorgdrager, *Cornelius Gisbert* [*c.* 1650–170–] Bloeyende opkomst der aloude en hedendaagsche Groenlandsche visschery, etc. Amsterdam, 1720. xxxi, 330 p. 7 pls. frontisp. maps. Pre-Linn. 1720.1

Other Dutch eds.: The Hague, 1727; Amsterdam, 1728; Delft, 1746.

—— Alte und neue Grönländische Fischerei und Wallfischfang . . . Zu Ende ist allhier beigefüget eine summarische Nachricht von dem Bakkeljau- und Stockfischfang bei Terreneuf (in den nordlichen Theilen von America, aus den Schrifften des Herrn Danys gezogen) Leipzig, 1723. xxvi, 482 p. 7 pls. 6 maps. 4°. Pre-Linn. 1723.1

Other German versions: Nuremberg, 1722 & 1750.

LIST OF PRE-LINNÆAN ANONYMOUS TITLES[1]

Pre-Linnæan Anonymous. Allt Schonbuch Recht und Gefell [M. S. 1383] Anon. 713

Land register of the Schönbuch in Württemberg. Rental paid for the fishing stream Steinach. Mentions the following fishes as occurring in the Steinach: Schuppfisch (*Squalius cephalus*); Bartgrundel (*Cobitis barbulata*); Ellritze (*Phoxinus laevis*); Grundel (*Gobio fluviatilis*); Gruppe (*Cottus gobio*).

For further data, *see* Tscherning, F. A., 1899.1

—— Arte del pescare. Venezia, 1693. 12°. Anon. 714

—— Avis sur une lanterne de cuir qui conserve la lumière sous l'eau même, très-utile pour la pêche, inventée par Mr. Scarlet. (In Observations curieuses sur toutes les parties de la physique. Paris, 1719. 8°.) Anon. 715

German version: "Unterricht in der Fischerey." 2nd ed. Nürnberg, 1758.
Not seen; titles from Cloquet & Walbaum.

—— Beschreibung des wunderbahren Fisches [Thynnus], so den 12. Novbr. Anno 1709 zu Ystädt in Schonen etc. an das Land geworffen worden, nebst desselben accuraten Abriess in Kpfr. gestochen. 1710. 4 p. 4°. Anon. 716

—— Beschreibung eines sehr grossen Fisches welcher bey Neapolis einen Fischer verschlungen. Berlin, 1721. 4°. Anon. 717

—— Bewährtes Mittel um eine Menge Fische mit der Angelruthe oder dem Netze zu fangen. Bremischen Mag., 1757, **1**, 507. — London Mag., 1755. Anon. 718

—— Dit Boecxken leert hoe men mach voghelen vanghen metten handen. Ende hoe men mach visschen vangen metten handen. Ende oeck andersing. Ende oeck tot wat tyden vanden iare dat een yeghelyck visch tsynen besten is. Hier eyndet een boecxken dat seer profiteliick is voer allen visschers, ende vogheleers. [Antwerp, 1492?]. 8 leaves. 6 woodcuts. 4°. Anon. 719

This Flemish tract appears to have priority over the "Book of St. Albans," as far as fishing is concerned; that is, as a printed book. There are a number of early German versions, appearing under the title of "Büchlin" or "Fischbüchlin," published between 1552 and 1700. One of these is included in the Fischbuch of Gregory Mangolt, published at Zurich in 1598. Three other editions are known: one in 4°, without place or date, having an identical title; the other, slightly changed in verbiage, in 1583 without place; and the third in 1584. For notes on these editions *see* Westwood & Satchell, p. 35–37. For an English translation, *see* Denison, A., 1872.1.

—— Ein Büchlein wie man Fisch und Vögel fangen soll, mit 30 neuen und bewährten Recepten, auch zu welchen Zeiten im gantzen Jahr ein jeder Fisch am besten zei. Erfurt, 1610. 8°. Anon. 720

Boehmer for same date and place gives a slightly variant title.

—— A booke of fishing, with hooke and line, and all other instruments thereunto belonging. 1590. 4°. Anon. 721

Another ed., 1606. Data from Boehmer.

—— La canna de pescare. 1612. 250 p. Anon. 722

Title only cited by Westwood & Satchell, 1883.

—— Chür-fürstlicher Pfaltz, Forst- und Wald- auch Weid-, Wercks-, Jagd- und Fischerey- Ordnung. Heydelberg, 1711. 28, 148 p. table. sm. 4°. Anon. 723

—— The complete grazier; or, Gentleman and farmer's directory . . . also directions for making fish-ponds or canals, and for storing them, and ordering the fish in the best manner . . . London, 1677. xii, 252 p. 12°. Anon. 724

Fish ponds, p. 244–252.
Other eds.: London, 1775 & 1776.

—— The country gentleman's companion. 2 vols. London, 1753. 12°. Anon. 725

Vol. I, chaps. XVII. Of fishing in general, and of making fish ponds; XVIII. Of taking all sorts of fish: vol. II, chaps. VIII. Of angling in general; IX. Of angling seasons; X. Of bait; of preserving fish from enemies; XII. Of ordering ponds.

Other eds.: Dublin, 1755; London, 1756.

—— Cyanea, oder die am Bosphoro Thracio liegende hohe Klippe, von welchen zu sehen seyn das Vormeer Propontis, das schwarze Meer, Pontus Euxinus, Cypern, Candien &c. darinnen befindliche Thiere, Vögel, Fische &c. Augspurg, 1687. 26 pls. 8°. Anon. 726

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[1] For lists of Anonymous Titles after 1758, *see* in volume II (p. 677–702) and in this volume (p. 1–3).

—— De piscinarum utilitate & quæ in iis exstruendis piscibusque replendis observanda sunt. Oecon. Nachricht., Leipzig, 1751, **2.** Anon. 727

—— [De piscium somno sive stupore hiemali] Oecon. Nachricht., 1754, **6.** Anon. 728

—— Descriptio piscis, qui figuram habentis Eggfisch dicti. Gentleman's Mag. Hist. Chron. [Urban's], 1753, **23,** 17. Abstract in Comment. Lips., **4,** 61. Anon. 729

—— A description [and figure] of the cavalli marine [sea horse]. Gentleman's Mag. Hist. Chron. [Urban's], 1753, **23,** 112. fig. Anon. 730

Interesting early figure of sea horse. Copy, N. Y. P.

—— A description of three hundred animals; viz., beasts, birds, fishes, serpents and insects. London, 1730. 212 p. 8°. Anon. 731

Other eds.: London, 1734; (with slightly varying titles) 1736, 1738, 1740, 1753. Suppl. vols., London, 1739 & 1753. In the 1753 ed. are described 54 fishes. The 1753 supplement is:

—— A description of a great variety of animals and vegetables, viz. beasts, birds, fishes . . . extracted from the most considerable writers of natural history. London, 1753. 90 pls. 8°. Anon. 732

—— Dictionnaire universel d'agriculture et . . . pêche . . . Avec des règles pour la volerie, la chasse et la pêche, etc. 2 parts. Paris, 1751. pls. 4°. Anon. 733

—— Diere palleys. . . . Van de visschen en monstre d'watere. Thantwerpen, 1520. sm. fol. Anon. 734

"Dat derde tractaat bescrijft de naturen der beesten, monstren en de visschen der zee ende der wateren." — Bosgoed.

—— Difesa della real mensa Vescovile di Pozzuoli per l'esazzione della decima della pesca ne' mari di sua diocesi. Con li pescatori di Procida. Napoli, 1737. 8 leaves. 4°. Anon. 735

—— Dritter Theil des klugen Haus-Vaters. (Gründliche Nachricht von der Fisch-Zucht, dem Ackerbau, Weisemachs und Fischerey, etc.) Leipzig, 1721. 4°. Anon. 736

—— Dyalogus creaturarum moralizatus. Gouda, 1480. fol. Anon. 737

Contains the earliest known printed figure of use of float in fishing.

1st ed.; 2nd, Cologne & Paris, 1481.

—— Dyalogus creaturarum moralizatus. Gouda, 1482. fol. Anon. 738

Leaves 38–44: De . . . piscatore, with several quaint woodcuts of fish, probably among the very earliest produced.

Many other editions issued but titles and dates not available. An old English version, supposed to be the 1st, is:

—— The dialogues of creatures moralysed, applyably and edificatyfly to every mery and iocunde mater, of late translated out of Latyn into our Englysshe tonge right profitable to the gouernaunce of man. [1520?]. 164 leaves. woodcuts. 4°. Anon. 739

Copies, 1st ed., J. P. M. & H. E. H.; 1481 ed., C. P.; 1482 ed. Gouda, H.

For a modern reprint, *see*, Haslewood, J., 1816.1; and for a late commentary, Klemming, G. E., "Dialogus creatuarum moralizatus" Samlaren. Tidskrift Utgifven af Svenska Literatursällskapets. Arbetsutskott. Upsala, 1896. Argång 5, 36–42.

—— Das edle Fisch-Buechlin, das ist: Ein sehr nuetzlicher Bericht, von der Fischerei ueberaus grosser Nützbarkeit; von der Fische Natur und Eigenschaft, etc. Nürnberg, [1700]. 190 p. 8°. Anon. 740

Another ed., Cologne, [n. d.]

—— Einige zur natürlichen Historie der Forellen gehörige Nachrichten, und was zu deren Vermehrung dienlich. Stutg. Sel. Phys. Oecon., 1750, **1,** 112. Anon. 741

—— Encyclopédie japonaise [*ante* 1727]. Anon. 742

Under this heading, Valenciennes records four collections of native paintings of Japanese fishes extant in his day: one in the Bibliothèque du Roi; another in the Museum d'Histoire Naturelle de Paris; another in the collections of Sir Joseph Banks; and the fourth belonging to the Duc de Rivoli. The first comprised figures of 76 fishes; the 2nd & 3rd 83 & 84 each, and the last 31. The date can be fixed approximately since it is known that Kaempfer (*q. v.*) had some of these engraved for his "History of Japan."

—— Extrait d'une lettre écrite à M. de la Chambre, qui contient les observations qui ont été faites, sur un grand poisson (*Renard marin*) disséqué dans le Bibliothèque du Roi le 24 July, 1667. Paris, [1667] pls. 4°. Anon. 743

See also Anon. 769.

—— Fishbuchlin, von der Natur und eigenschafft der Fischen. Item, wie man Fisch und Vögel fahen sol. Zu welcher zeit auch jeder Visch am besten sey. Straszburg, 1578. 8°. Anon. 744

This has been attributed to Gregory Mangold.

—— Fishing and hunting. . . . The art of fishing and sundry curious baits, viz. worms, flies, pastes, etc. . . . and how to procure and keep them for fishing; how to bring the fish to any part of the pond; to make worms for bait come out of the ground; the artificial cad-fly; how to take the fish in the night; the best time to angle in, etc. London, (1720?). 64 p. 8°. Anon. 745

—— Gedanken von dem Feig der Fische. Oecon. Physik. Abhandl., Lipsiæ, 1753, 428. Anon. 746

—— The gentleman angler. Containing short, plain and easy instructions whereby the most ignorant beginner may, in a little time, become a perfect artist in angling for salmon . . . gudgeon, etc. London, 1726. 12°. Anon. 747

Other eds.: London, 1736, 1753, 1760, 1786, 1828. This last, "The anglers Guide," etc. is the best. Copies 1st and 2nd eds., N. Y. P.

—— The gentleman fisher: or the whole art of angling. London, 1727. vi, 112 p. 8°. Anon. 748

For 1st ed., *see* Anon. 785.

—— Gewise und bewerthe Künste, wie man Fisch und Vögel fahen soll . . . etc. Item von der Natur unnd Eigenschafft vieler Fisch, *etc.* Nürnberg, 1612. 12°. Anon. 749

—— Harenga habita in monasterio Cluniacensi ad cardinalem de Lotharingia. Rhemis, 1566. 8°. Anon. 750

—— Haus-Buch, . . . auch wie reiche und nutzbringende Fische-Teiche anzurichten, die Fische auf das beste zum merklichen Nutzen zu allen Zeiten des Jahrs wol und erspriesslich zu erhalten seyen, etc. Nürnberg, 1710. 12°. Anon. 751

—— Hausbuch Neu-Curioses, eidgenössisch-schweizerisches. Basel, 1705. Anon. 752

Chap. xv, Swiss fishes.

Reprinted, Pfäffikon, 1897.

—— Herbarum, arborum, fruticum, frumentorum et leguminum, animalium terrestrium, volatilium, aquatilium aliorumque, quorum usus est in medicina imagines ad viuum depictæ, una cum earundem nomenclaturis. Francofurti, 1536, pt. 1 and 2. 4°. Anon. 753

This may have been the basis of a similar work by Charles Estienne, 1536.1 (*q. v.*).

Other eds. are: Paris, 1536, 1545, & 1554; Leyden, 1548; Frankfort, 1546 (German), & 1552.

—— Histoire des animaux à quatre pieds, des oiseaux, des poissons &c. Paris, 1619. 8°. Anon. 754

—— Histoire naturelle des oiseaux peu communs & des autres animaux rares & qui n'ont pas été descrits, consistant en quadrupèdes, reptiles, poissons, insectes &c. 7 vols. Londres, 1751–63. 4°. Anon. 755

—— Histoire naturelle du Languedoc. Paris, 1728. 4°. Anon. 756

Poissons, p. 549–578.

Another ed., Paris, 1737, contains descriptions of fossil fishes and of the capture of the mullet.

—— Histoire universelle des poissons et autres monstres aquatiques. Paris, 1584. 12°. Anon. 757

—— Kurzer Begriff der edlen Jägerei . . . nebst einem Anhange von der Fischerei, etc. Nordhausen, 1730. 36 pls. 8°. Anon. 758

"Fischerei," p. 1–136.
Other eds.: Nordhausen, 1733, 1742, 1745.

—— Liber œconomicus [des Jesuitklostern zu Passau an der Donau, MS. 1709–1763] Anon. 759

This "Haushaltungsbuch" of the Passau monastery contains, according to J. Wimmer, interesting data concerning fish of the Danube region.

—— Mémorial alphabétique des matières des eaux, forêts, pêches et chasses, avec les édits. Paris, 1737. 4°. Anon. 760

—— El modo como se puede destruyr cada uno la pesca de los harengues de manera que no de frute ninguno. 1632. Anon. 761

In the Burgundian Library, Brussels.

—— Nachricht vom Hayfisch. Ges. Erzähl., Hamburg, 1754, **3**. 8°. Anon. 762

—— La nature et propriété des poissons et autres monstres aquatiques, qui hantent et habitent aux mers, rivières et estangs; avec leurs pourtraicts et figures exprimez au plus près du naturel. Paris, 1584. 16°. Anon. 763

An earlier ed. exists, date not known.

—— Neue und bewahrte Recepten, Fische und Vogel zu fahen mit den Handen, Reussen, Angeln, Hammen, Netzen. 1580. 8°. Anon. 764

This appears to be a part of the 1552 edition of the "Büchlin" (*q. v.*), Anon. 720.

—— Neuw Jag unnd Weydwerck Buch, das ist eine gründtliche Beschreibung vom Anfang der Jagten . . . vom Fisch, Krebs, Otter vnd Biber Fang, wie mans mit Netzen, Reusen, Angeln, Kasten, Otter vnd Biberhunden, vnd allerley darzu gehoriger Gelegenheit fahen sol . . . Franckfurt am Meyn, 1582. fol. Anon. 765

—— New and excellent experiments and secrets in the art of angling: being directions for the whole art. London, 1677. 12°. Anon. 766

—— A new general collection of voyages and travels, etc. 4 vols. London, 1745–47. illust. Anon. 767

Consists of abstracts or abbreviations of a large number of voyages and travels with numerous figures and descriptions of fishes. Copy, A. M. N. H.

—— Observations faites sur un grand poison [sic] [*Vulpecula marina*], & un lion, disséqués dans la Bibliothèque du Roy à Paris, le 24 & 28 Juin, 1667. Phil. Trans. Roy. Soc., 1667, **2**, 535–537. Anon. 768

Undoubtedly based on Anon. 743.
Both these references have to do with the dissection by Claude Perrault (*q. v.*) of the fox shark. Antedating Perrault's own description (1671) of the spiral valve, they are among the earliest known references to this. For the earliest, *see* Steno, N., Pre-Linn. 1664.1.

—— A perfect description of Virginia: being a full and true relation of the present state of the plantation, their health, peace & plenty: the number of people, with their abundance of cattell, fowl, fish, &c. London, 1649. 4°. Anon. 769

Contains a list of 32 fishes. Reprinted in Force's Historical Tracts, **2**, tract 8. Extract in Rept. U. S. Fish. Comm. 1871–72 (1873), 170–171.

—— Pertinente beschryvinghe van Guiana, gelegen aen de vaste kust van America, waerin kortelyck verhaelt wordt, het aenmerckelyckste dat in en omtrent het landt van Guiana valt, etc. Amsterdam, 1676. 12 & 55 leaves. 4°. Anon. 770

Fishes, p. 37–41.
Copy in Surg. A German version is:

Eigentliche Beschreibung des Landes Guiana, etc. 1677.

—— Pesci che nascono nel Danubio, e volatili che vivono lungo d'esso delineati ed incisi in tavole CXII. Bologna, [n. d.] fol. Anon. 771

—— Piscis vel potius testudinis aquaticæ nova species descripta. Mag. Toscano, Livorno [Leghorn], 1754, **2**, 363. Anon. 772

—— Poissons des Indes Orientales; recueil de 66 dessins en couleurs. fol. Anon. 773

"Ces dessins qui semblent avoir été faits en Hollande au commencement du 18. siècle, sont d'une exécution remarquable."
The copy in A. M. N. H. has the water-color figures cut out of the original drawing paper and pasted on the leaves of the volume.

—— Principales merveilles de la nature, ou l'on traité de la terre, des fleuves, montagnes, des choses les plus rares animaux, poissons, plantes, diamants etc. 2 vols. Amsterdam, 1745. 8°. Anon. 774

—— Regimen sanitatis Salernitanum, etc. Montpelier, 1480. 4°. Anon. 775

An esteemed work whose merit and popularity are attested by the vast number of editions printed. There were six issued in 1480, the above being the *editio princeps*. Twenty eds. were published before 1500, and over 160 by 1830. There are translations into French, German, English, Dutch, Italian, Polish and Bohemian. For bibliographic details of these eds. and versions, *see:*

Regimen sanitatis salernitanum: a poem on the preservation of health in rhyming Latin verse. With an introduction and notes by Sir Alexander Croke. Oxford, 1830 [with ills. from the German eds. of 1559, 1568, & 1573] Copy Col.

The following eds. (both in Col. Univ. library) have been examined by us.

—— Regimen sanitatis Salerni: or the school of Salernes regiment of health . . . Whereunto is annexed a necessary discourse of all sorts of fish, in use among us, with theyr effects, appertayning to the health of man. London, 1634. Anon. 776

Various fish named and their value as food discussed, p. 207–218.

—— Schola Salernitana de valetudine tuenda. Lutitiæ Parisiorum, 1672. Anon. 777

Various fishes as food and the proper choice of them, p. 673–722.

—— Scriptores rei rusticæ. Venice, 1472. fol. Anon. 778

The 1st ed. of this compilation, which was many times republished. Other 15th century eds.: Reggio d'Emilia, 1482, 1496, & 1499; Bologna, 1492. Copies of these early issues in H., C., J. C., & H. E. H.

Some later eds. are: Basel, 1521 & 1576; Leyden, 1542, 1549, & 1604; Paris, 1545, 1569, 1581, & 1585; Dordrecht, 1619; Amsterdam, 1623, & 1730; Leipsic, 1735, & 1744; Mannheim, 1781; Biponti, 1782–88; Leipsic, 1794–97.

The most famous eds. are the last, by J. G. Schneider, and those of Leipsic, 1735 and Biponti, 1787, by J. M. Gesner (Both in N. Y. P.).

This compilation recounts some of the earliest known efforts at pisciculture.

For further references, *see* in this section: Cato, Columella, Palladius, & Varro.

—— The sportsman's dictionary; or, the country gentleman's companion . . . with full and particular instructions for . . . fishing, etc. 2 vols. London, 1735. 4°. Anon. 779

Other eds.: London, 1744, 1778, 1782, 1785, 1786 (Dublin), 1792, 1800, 1807.

—— Treatise of fishing, with the art of angling. 1614. 4°. Anon. 780

—— [Ut pisces compresso aëre sub glacie ſtupidi reddantur.] Oecon. Nachricht., 1754. **5**. Anon. 781

—— Von des Aals Laichen. Samml. Nat. u. Med., Kunst u. Litt.-Gesch. Breslau, 1718, 1224. Anon. 782

—— Von einem in Rom gefangenen Stöhr. Samml. Nat. u. Med., Kunst u. Litt.-Gesch. Breslau, 1718, 5. Vers., 1531. Anon. 783

From Boehmer. Walbaum says Tentam. 32, p. 433.

—— Waidweryk . . . Fisch zufahen mitt Netzen, Reusen, Angeln, Kasten . . . Und wie man alles darzu dienlich, bereytten, auffziehen, halten, und machen soll. Augsburg, *c.* 1525. 20 leaves. 4°. Anon. 784

Other eds. are: Strassburg, 1530, & Frankfort-a.-M., 1531.

—— The whole art of fishing. Being a collection and improvement of all that has been written upon this subject, with many new experiments . . . To which is added the laws of angling. London, 1714. 112 p. 8°. Anon. 785

Copy, N. Y. P. *See* also Anon. 748.

—— Ein wunder künstreiches Büchlin, wie man Fisch, Krebss, und Vögel fahen soll. Mit gar vil bewehrten Recepten, etc. Von vil erfarnen Weydleüten, und Fischern, von neuwem zugericht, etc. Und auch hie bey zu welcher Zeit ein yeder Fisch am besten ist. Strassburg, *c.* 1531. 24 p. 12°. Anon. 786

Another ed. with almost identical title, Bern, 1552. 8°.

This is a translation of the early Flemish treatise on fishing commonly designated as "Boecxken" (Anon. 719), printed in black letter about 1492. On the last page of the 1552 edition is an interesting list of nicknames and similitudes of fish.

IV

GENERAL BIBLIOGRAPHIES WHICH INCLUDE REFERENCES TO FISHES.[1]

—— An analytical subject bibliography of the publications of the [U. S.] Bureau of Fisheries, 1871–1920. By Rose M. E. MacDonald. (Append. V to) Rept. U. S. Comm. Fisheries, 1920. 306 p. 8°.

—— Archiv für Naturgeschichte, 1835–1919. 85 vols. Berlin, 1835–1920. 8°.

Each year's issue in 2 pts., memoirs and bibliography.

—— The Bartlett collection. A list of books on angling, fishes, and fish-culture in Harvard College library. By L. R. Albee. Cambridge [Mass.], 1896. 180 p. 8°.

This includes, with many additions, the titles in Bartlett, J. 1882.1.

—— Bibliografia ed inventario delle ittioliti terziarie di Monte Bolca conservate nel Civico Museo di Verona. By Vittorio dal Nero. Madonna Verona, 1911, **2**, 120–126; **3**, 133–167: 1912, **4**, 246–260.

—— Bibliographia zoologica (adhuc diario "Zoologischer Anzeiger" adnexa) condita ab J. Victor Carus, edidit, sub cura doctoris Herbert Haviland Field. Concilium Bibliographicum. 29 vols. Zurich, 1896–1916.

See also "Zoologischer Anzeiger."

—— Bibliographia zoologiæ et geologiæ. A general catalogue of all books, tracts, and memoirs on zoology and geology. By Louis Agassiz. Corrected, enlarged, and edited by H. E. Strickland (and Sir Wm. Jardine [for vol. IV]). 4 vols. London, 1848–54. 2259 p. 8°.

—— A bibliographical catalogue of the Waltonian library belonging to the estate of R. W. Coleman. By Joseph Sabin. New York, 1866. 149 p. 8°.

This includes the works listed in Bethune, G. W. 1847.1. A sale catalogue (36 p. 4°.) of this collection is dated London, 1897.

—— Bibliographie der deutschen naturwissenschaftlichen Litteratur. [1901–1914] 18 vols. Jena & Berlin, 1902–14. 8°.

Vols. for 1904–14 published at Berlin.

—— [Bibliographie d'] Ichthyologie. By Hippolyte Cloquet. Dictionnaire des Sciences Naturelles. Paris, 1821, vol. XXII, 443–548.

—— Bibliographie des travaux scientifiques (sciences mathématiques, physiques et naturelles) publiés par les sociétés savantes de la France depuis l'origine jusque'en 1888. By J. Deniker. Paris, 1916. 607 p. 4°.

Vol. I, Ain-Orne, all published to date.

—— Bibliographie der Veröffentlichungen [der wissenschaftlichen Vereine und Gesellschaften Deutschlands im neunzehnten Jahrhundert] seit ihrer Begründung bis auf die Gegenwart. By Johannes Müller (librarian). Berlin, 1883–87. 878 p. 4°.

See also Müller, J. (librarian) 1883.1.

—— Bibliography and catalogue of the fossil vertebrates of North America. By Oliver Perry Hay. Bull. U. S. Geol. Survey, 1902, no. 179, 868 p.

This includes the titles on fossil fishes found in Darton, N. H. 1896.1; Weeks, F. B. 1902.1; and Warman. P. C. 1893.1, and 1901.1. For titles since 1902, *see* the following:

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[1] There are here brought together the chief bibliographies known to us containing extensive references to Fishes, Fisheries, Pisciculture, and Angling.

Reference to special bibliographies on particular or restricted subjects will be found throughout the Subject Index under their respective sections. In general, citations indicated by a star or by black-faced type will be found to contain special bibliographies of the subject.

—— Bibliography of North American geology, palæontology, etc. Bull. U. S. Geol. Surv., 1901–19.

I. 1901–05. By F. B. Weeks. Bull. 1906, no. 301. 770 p.

II. 1906–07. By F. B. Weeks & J. N. Nickles. Bull. 1908, no. 372, 317 p.

III. 1908–18. By J. N. Nickles. Bull. 1909–19, nos. 409, 444, 495, 524, 545, 584, 617, 645, 665, 684, 698.

—— A bibliography of fishes. By Bashford Dean. 3 vols. New York, 1916–23. 8°.

Vols. I & II, enlarged and edited by C. R. Eastman, 1420 p.
Vol. III, extended and edited by E. W. Gudger; assisted by A. W. Henn.

—— Bibliography of fishes of the Pacific coast of the United States to the end of 1879. By Theodore N. Gill. Smithson. Misc. Colls., 1882, **23,** 1–73.

—— A bibliography of vertebrate embryology. By C. S. Minot. Mem. Boston Soc. Nat. Hist. 1886–93 (1893), **4,** 487–618.

—— Bibliotheca anatomica quo scripta ad anatomiam et physiologiam facientia a rerum initiis recensentur. By Albrecht von Haller. 2 vols. Tiguri, 1874–77. 1686 p. 4°.

—— Bibliotheca animalis oder Verzeichniss derer meisten Schriften, so von Thieren und deren Theilen handeln, etc. By Franz Ernst Brückmann. Wolfenbüttel, 1743. 277 p. 8°.

A supplementary volume was issued, 1747.

—— Bibliotheca historico-naturalis, . . . oder systematisch geordnete Uebersicht . . . der auf dem Gebiete der gesammten Naturwissenschaft neuerschienenen Bücher, etc. 38 vols. Göttingen, 1851–88. 8°.

—— Bibliotheca historico-naturalis. Verzeichniss der Bücher über Naturgeschichte . . . welche in den Jahren 1700–1846 erschienen sind. Von Wilhelm Engelmann. Leipzig, 1846. 786 p. 8°.

Continued as "Bibliotheca zoologica, Verzeichniss," etc. (*q. v.*).

—— Bibliotheca Hungarica historiæ naturalis et matheseos. Magyarorszig természettunományi is mathematikai Könyveszete, 1472–1875. By Jossef Szinnyei and Jozef Szinnyei (the younger). Budapest, 1878. 1007 p. 8°.

—— Bibliotheca ichthyologica sive historia litteraria ichthyologiæ in qua recensio fit auctorum, qui de piscibus scripsere, librorum titulis, loco & editionis tempore, etc. By Peter Artedi. Lugduni Batavorum, 1738. 66 p. 8°.

Part i of Artedi, P. Pre-Linn. 1738.1.
For a revised and augmented ed., *see* next title.

—— Bibliotheca ichthyologica, seu historia litteraria ichthyologiæ, etc. Emendata et aucta, etc. By Johann Julius Walbaum. Grypeswaldiæ, 1788. 230 p.

Part i of "Petri Artedi renovati," etc., by J. J. Walbaum, 1788.1.

—— Bibliotheca, ordine chronologico recensens Daniæ, Norvegiæ, Islandiæ & Holsatiæ auctores et libros, scientias naturales tractantes, etc. By Martin Thrane Brünnich. Pt. II of his "Litteraria Danica Scientiarum Naturalium." Hafniæ & Lipsiæ, 1783. 242 p.

—— Bibliotheca ichthyologia et piscatoria. Catalogue de livres et d'écrits sur l'histoire naturelle des poissons et des cétacés, la pisciculture, les pêches, la législation des pêches, etc. By D. Mulder Bosgoed. Harlem, 1874. 474 p. 8°.

Second title-page is in Dutch. For an earlier ed., *see* Bosgoed, D. M. 1871.1.

—— Bibliotheca piscatoria. A catalogue of books on angling, the fisheries and fish-culture, with bibliographical notes, etc. By Thomas Westwood & Thomas Satchell. London, 1883. 397 p. 8°.

This work includes the titles found in and hence supersedes: Bethune, G. W. 1847.1; Ellis, H. 1811.1; Pickering, W. 1836.1; Satchell, T. 1882.1; Smith, J. R. 1856.1; Westwood, T. 1861.1. For a supplement, *see* "A list of books on fish," etc., by R. B. Marston, 1901.1.

—— Bibliotheca regni animalis atque lapidei, seu recensio auctorum et librorum, qui de regno animali et lapides . . . in usum naturalis tractant, historiæ studiosorum. By Laurentius Theodorus Gronovius. Lugduni Batavorum, 1760. 326 p. 4°.

—— Bibliotheca scriptorum historiæ naturalis, oeconomiæ, aliarumque artium ac scientiarum ad illam pertinentium realis systematica. By George Rudolph Boehmer. 2 vols. [in 2 pts. each] Lipsiæ, 1785–86. 2690 p. 8°.

The most extensive bibliography of natural history *ante* Agassiz & Strickland.

—— Bibliotheca scriptorum historiæ naturalis omnium terræ regionum inservientium; historiæ naturalis Helvetiæ prodromus. Accedit Jacobus Le Long de scriptoribus historiæ naturalis

Galliæ. By Johann Jacob Scheuchzer. Tiguri, 1751. 251 p. 8°.

An earlier ed., Tiguri, 1716.

—— Bibliotheca scriptorum venaticorum continens auctores, qui de venatione, sylvis, aucupio piscatura . . . commentati sunt. By Georg Christopher Kreysig. Altenburgi, 1750. 190 p. 8°.

—— Bibliotheca zoologica Danica, 1876–1906. Fortegnelse over Danmarks zoologiske literatur, 1876–1906. By Svend Dahl. Kjøbenhavn, 1910. 262 p. 8°.

—— Bibliotheca zoologica Fenniæ. By O. M. Reuter and Alexander Luther. Acta. Soc. Faun. Flora Fenn., 1909, **24**, no. 1, 361 p.

Bibliotheca zoologica. Verzeichniss der Schriften über Zoologie . . . welche vom Jahre 1846–1860 selbständig erschienen sind, etc. By J. Victor Carus and Wilhelm Engelmann. 2 vols. Leipzig, 1861. 2140 p. 4°.

This is a continuation of "Bibliotheca historico-naturalis," etc., (*q. v.*), and in turn is continued as:

—— Bibliotheca zoologica II. Verzeichniss der Schriften über Zoologie . . . welche vom Jahre 1861–1913 selbständig erschienen sind. By O. Taschenberg. 7 vols. Leipzig, 1887–1913. 6072 p. 4°.

—— Bibliothek der Forst- und Jagd-Wissenschaft; oder Verzeichniss der in älterer und neuer Zeit, besonders aber vom Jahre 1750 bis gegen Ende des Jahres 1842 in Deutschland erschienenen Bücher über alle Theile des Forst- und Jagdwesens, über die Fischerei, etc. By T. C. F. Enslin & W. Engelmann. Leipzig, 1843. 102 p. 8°.

2d ed. revised by Engelmann: 1st by Enslin, 1823. Continued as:

—— Bibliothek der Forst- und Jagd-Literatur. Ein Verzeichniss der über alle Theile des Forst- und Jagdwesens und über Fischerei in Deutschland erschienenen Schriften umfassend dem Zeitraum vom Jahre 1842 bis zum Jahre 1856, etc. By F. W. Schneider. Berlin, 1856. 63 p. 8°.

—— Bibliothek der gesammten Naturgeschichte. By Johann Fibig & B. S. Nau. 2 vols. Frankfurt-am-M., 1789–91.

—— Bibliothèque physique de la France, ou liste de tous les ouvrages tant imprimées que manuscrits qui traitent de l'histoire naturelle de ce royaume. By L. A. P. Herissant. Paris, 1771. 8°.

—— Bidrag till öfversigt af Sveriges ichthyologiska literatur. By Frederic Lundberg. Stockholm, 1872. 56 p. 8°.

—— Catalogue of the books, manuscripts, maps and drawings in the British Museum (Natural History). 5 vols. London, 1903–1915. 2403 p. 4°.

—— A catalogue of the collection of books on angling belonging to Dean Sage. New York, 1896. 245 p. sq. 8°.

A supplement (24 p.) was issued in 1904.

—— Catalogue of the library of the late John G. Hecksher. 3 parts. New York, 1909. 382 p. 12°.

Lists 2442 items in ichthyology, angling, and fisheries.

—— Catalogue of scientific papers (1800–1900) compiled by the Royal Society of London. 17 vols. London, 1867–1921. 4°.

Issued in 4 series (4th incomplete), and commonly known as the "Royal Society Catalogue."

—— Catalogus doctorum virorum, qui præter Oppianum de venatione et piscatione, aut rebus ad eam pertinentibus scripserunt. By Conrad Rittershusius in his "Prologomena in Oppianum." Lugduni Batavorun, 1597. leaves 74 & 75.

The oldest known list of writers on fish and fishing.

—— Check list of books on angling, fish, fisheries, fish-culture, etc., in the library of D. B. Fearing. New York, 1901. 138 p. 4°.

This remarkable collection is now in the Harvard library.

—— Concilium Bibliographicum. H. H. Field, editor. Zurich, 1896–1920.

A system of bibliographical cards arranged alphabetically by authors, and numerically by subjects. *See* also "Bibliographia zoologica."

—— Deliciæ Cobresianæ. Büchersammlung zur Naturgeschichte. By J. P. Cobres. 2 vols. Augsburg, 1781–82. 956 p.

—— Elementi per una bibliografia italiana intorno all' idrofauna agli allevamenti degli animali acquatici e alla pesca. By Guelfo Cavanna. Firenze, 1880. 170 p. 8°.

—— Exposé des titres et travaux scientifiques (1869–1896). By Alfred Giard. Paris, 1896. 300 p. 4°.

—— Index auctorum, qui de piscibus eorumque vario usu scripserunt, quorumque in hoc libro aut ab Artedio mentio facta est, ad seculum deductus. By J. G. Schneider in his " Petri Artedi Synonymia piscium Graeca et Latina emendata . . . Sive Historia piscium . . . ab Aristotelis usque ævo ad seculum XIII deducta," etc. Lipsiæ, 1789. 227–246.

—— International catalogue of scientific literature. London. 8°.

I. Section K. Palæontology. 13 vols. 1903–1916.

II. Section N. Zoology. 1904–1914.

The first 5 vols. of Section N (1904-1907) appeared as separate issues; those for 1908-1914 in and as the Zoological Record with 2 title pages.

—— A list of books on fish, fishing, and fisheries, to supplement the " Bibliotheca piscatoria " of Westwood & Satchell published in 1883, etc. By R. B. Marston. London, 1901. 24 p. 8°.

Literatur zur Fischkunde. By H. Lichtenfelt. Bonn, 1906. 140 p. 8°.

—— Literaturæ scientiæ rerum naturalium in Dania, Norvegia & Holsatia usque ad annum 1829, etc. By Mathias Winther, Havniæ, 1829. 233 p. 8°.

—— The record of zoological literature, 1864–69. 6 vols. London, 1865–70. 4°.

Continued as "The Zoological Record." (*q.v.*).

—— Reportorium commentationem a societatibus literariis editarum scientia naturalis. By J. D. Reuss. 2 vols. Gottingiæ, 1801–1802. 988 p.

—— Systematisches Verzeichniss aller derjenigen Schriften welche die Naturgeschichte betreffen, von den ältesten bis auf die neuesten Zeiten. By Christ. Fred. Prange. Halle, 1784. 446 p.

—— Udsigt over Danmarks zoologiske literatur med en indledende fremstelling af de videnskabelige grundsætninger for naturvidenskabens især zoologiens studium. By C. C. A. Gosch. 2 vols. Kjøbenhavn, 1875–78.

3d ed.; 1st, 1870, 360 p.; 2d, 2 vols., 1873.

—— Verzeichniss der Schriften und Abhandlungen, die norwegischen Fischereien betreffend, in chronologischer Ordnung zusammengestellt. By Thorvald Boeck. Christiania, 1880. 8°.

A revised and extended ed. of Boeck, T. 1866.1.

—— Zoologischer Anzeiger, 1878–1895. 18 vols. Leipzig, 1878–95. 8°.

For the years named, issued in 2 parts, "Mittheilungen" & "Litteratur." Succeeded in 1896 by "Bibliographia Zoologica." (*q. v.*).

—— Zoologischer Jahresbericht. Naples, 1879–1910 (1880–1911). 8°.

An abstract and bibliographical journal.

—— The zoological record, being records of zoological literature, 1870–1919. 56 vols. London, 1871–1921. 4°.

For earlier issues, *see* "The Record of Zoological Literature."

V

VOYAGES AND EXPEDITIONS WHICH RELATE TO FISHES[1]

"Albatross." — [Explorations of the U. S. Fish Commission steamer "Albatross" in the north Pacific, 1888–1900.]

Fishes, C. H. Gilbert, 1890.3, 1892.2, 1895.1, 1897.1, 1908.1.

—— Exploration of the west coast of Mexico, Central and South America, and off the Galapagos Islands . . . by the U. S. Fish Commission steamer "Albatross," during 1891.

Fishes, C. H. Gilbert, 1891.4; S. Garman, 1899.1.

—— [Explorations in the northwest Atlantic by the U. S. Fish Commission steamer "Albatross."]

Fishes, G. B. Goode, & T. H. Bean, 1896.1.

—— The expedition to the eastern tropical Pacific by the . . . "Albatross" . . . 1904–05.

Sharks' teeth, C. R. Eastman, 1906.3.

—— [The Philippine cruise of the U. S. Fisheries steamer "Albatross," 1907–10.]

Fishes, L. Radcliffe, 1911.1, 1912.1,.2, 1913.1,.2; H. M. Smith, 1912.2,.6, 1913.2.

——[The U. S. Bureau of Fisheries steamer "Albatross" in Japanese waters in 1906.]

Fishes, C. H. Gilbert & C. V. Burke, 1912.2; J. O. Snyder, 1912.1,.3.

"Alert" and **"Discovery."** — Voyage to the polar sea during 1875–76 in H.M.S. "Alert" and "Discovery."

Fishes, A. Günther, 1877.1, .3,.8, 1878.2.

Algeria. — L'exploration scientifique de l'Algérie pendant . . . 1844–67.

Fishes and reptiles, A. Guichenot, 1850.2.

"Amelia." — Resultados das investigações scientificas feitas a bordo do yacht "Amelia" [in the Mediterranean Sea and eastern Atlantic?].

Fishes, Dom Carlos de Bragança, 1899.1, 1904.1.

"Assistance." — The [Arctic] expedition in H.M.S. "Assistance" . . . during . . . 1852–54, under . . . Sir E. Belcher.

Fishes, J. Richardson, 1855.1.

"Astrolabe." — Voyage . . . de "L'Astrolabe" [autour du monde] . . . pendant . . . 1826–29, sous . . . M. J. Dumont d'Urville.

Fishes, J. R. C. Quoy, & P. Gaimard, 1834.1.

"Astrolabe" and **"Zélée."** — Voyage au Pôle Sud et dans l'Océanie sur . . . "L'Astrolabe" et "La Zélée" . . . pendant 1837–40, sous . . . J. Dumont d'Urville.

Fishes, H. Jacquinot & A. Guichenot, 1853.1.

"Aurora." — [Die Reise [in Japan] S. M. Schiff "Aurora" in den Jahren 1895 und 1896.]

Fishes, F. Steindachner, 1896.2.

Australasian Antarctic. — Australasian Antarctic expedition, 1911–14, under . . . Sir Douglas Mawson.

Fishes, E. R. Waite, 1916.1,.2.

Baluchistan. — Die Reise von Dr. Eric Zugmayer in Balutschistan, 1911.

Fishes, E. Zugmayer, 1913.3.

"Beagle." — The voyage of H.M.S. "Beagle," [around the world] under . . . Capt. Fitzroy, during . . . 1832–36.

Fishes, L. Jenyns, 1842.1.

"Belgica" (Greenland). — La croisière océanographique de "La Belgica" dans la mer du Grönland, 1905.

Fishes, E. Koefoed, 1909.2.

"Belgica" (Antarctic). — Expédition antarctique belge . . . voyage du S.Y. "Belgica," 1897 à 1899.

Fishes, L. Dollo, 1900.1–**1904.1.** Comments on this expedition, W. H. Dall, 1905.1; J. W. G. 1906.1.

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[1] A list of the chief voyages and expeditions known to us on which fishes have been collected in considerable numbers.

For a geographical arrangement comprising geographical works, narratives of travel, etc., *see* the section "Fauna of the World," of the Subject Index.

Titles are abbreviated or summarized. For full titles (so far as known to us), *see* in citation of author in footnote.

"Blake." — [Dredging in the Caribbean Sea and Gulf of Mexico and on the east coast of the U. S., 1878–80, in the U. S. Coast Survey steamer "Blake."]

Fishes, G. B. Goode & B. A. Bean, 1882.3, 1886.1, 1896.1.

Baltic Sea. — [The Russian expedition to the "Ostsee."]

Fishes, E. K. Suvorov, 1910.1, 1913.1.

"Blossom." — Capt. [F. W.] Beechey's voyage [in the ship "Blossom"] to the Pacific and Behring Straits in 1825–28.

Fishes, J. E. Gray, 1839.1; G. T. Lay & E. T. Bennett, 1839.1.

"Bonite." — Voyage autour du monde . . . pendant 1836 et 1837 sur . . . "La Bonite," commandée par M. Vaillant.

Fishes, A. Valenciennes, 1842.1. Comments on results, H. M. D. Blainville, 1838.1.

Borneo. — L'expédition scientifique néerlandaise au Bornéo central.

Fishes, L. L. Vaillant, 1902.1.

Cape Horn. — Mission scientifique du Cap Horn, 1882–83.

Fishes, L. L. Vaillant, 1888.3.

Castelnau. — Expédition dans les parties centrales de l'Amérique du Sud . . . pendant . . . 1843 à 1847.

Fishes, F. de Castelnau, 1855.1.

"Caudan." — La campagne du "Caudan" dans le golfe de Gascogne, août-septembre, 1895.

Fishes, R. Köhler, 1896.1.

"Challenger." — The voyage of H.M.S. "Challenger" [around the world] during 1873–76 under . . . Sir C. W. Thomson and J. Murray.

Fishes, A. Günther, 1877.6, 1878.3, 1880.5, 1887.5, 1889.8; H. N. Moseley, 1887.1; R. von Lendenfeld, 1887.2. Minor notes, narratives, etc., J. Murray, 1876.1; C. W. Thomson, 1877.1; W. J. Spry, 1876.1; R. von Willemoes-Suhm, 1875.1; H. N. Moseley, Add. 1876.1.

Charcot — L'expédition antarctique française (1903–05) commandée par Dr. Jean Charcot.

Fishes, L. L. Vaillant, 1906.1–**1907.1.**

"Chevert." — The "Chevert" expedition to New Guinea.

Fishes, H. G. Alleyne & W. M. Macleay, 1877.1.

"Coquille." — Voyage autour du monde . . . sur "La Coquille" pendant . . . 1822–25.

Fishes, R. P. Lesson, 1828.1, Add. 1830.1. Narrative, L. I. Duperry, 1826.1.

"Corsaro." — Crociero del "Corsaro" (alle Isole Madera e Canarie) del Capitano E. D'Albertis.

Fishes, D. Vinciguerra, 1883.1.

"Curaçoa." — Cruise of H. M. S. "Curaçoa" among the South Sea Islands in 1865.

Fishes, A. Günther, 1872.10, 1873.8. Narrative, J. L. Brenchley, 1873.1.

Danish Greenland. — Danmarks-Ekspeditionen til Grønlands nordøstkyst, 1906–08.

Fishes, F. Johansen, 1906.1.

East Indies. — Voyage aux Indes Orientales . . . pendant, 1825–29, par Charles Bélanger.

Fishes, A. Valenciennes, 1834.1.

—— Eine Reise in niederländisch Ost-Indien [1888–89].

Fishes, M. Weber, 1890.1.

Egypt. — L'expédition [en Egypte] de l'armée française [sous Napoléon Bonaparte], 1798–1801.

Fishes, E. Geoffroy-Saint-Hilaire, 1809.2; I. Geoffroy-Saint-Hilaire, 1827.1,.2.

"Endeavor" (Cook's First Voyage). — [An account of a voyage round the world, in the "Endeavor" in 1768–71.]

Fishes, D. C. Solander (MS.) 1768.1.

"Endeavor." — [Expedition of F. I. S. "Endeavor," 1909–10, in south Australian waters.]

Fishes, A. R. McCulloch, 1911.1, 1914.1, 1916.1.

"Erebus" and **"Terror."** — Voyage [into the Antarctic] of the "Erebus" and "Terror" under . . . Sir J. C. Ross during . . . 1839–43.

Fishes, J. Richardson & J. E. Gray, 1844.1.

"Fishhawk." — [Expeditions of the U. S. Fish Commission steamer "Fishhawk" in the northwest Atlantic.]

Fishes, G. B. Goode & B. A. Bean, 1896.1.

"Garland." — Trawling experiments of the "Garland" [Scottish Fisheries Board], 1889–1901.

Fishes, T. W. Fulton, 1890.5–1902.4; W. Wallace 1896.1. For trawling results etc., *see* Fishery Board for Scotland, under Fisheries, Scotland, in Index.

German East African. — Eine in . . . 1888–90 . . . von . . . F. Stuhlmann in die Küstengebiete von Ost-Afrika unternommenen Reise.

Fishes, G. Pfeffer, 1893.1,.2.

German Central African. — Die deutsche Zentral-Afrika Expedition, 1907–08.

Fishes, P. Pappenheim & G. A. Boulenger, 1914.1.

German East Asian. — Die preussische Expedition nach Ost-Asien [China, Japan, Borneo].

Fishes, E. von Martens, 1865.1, 1876.1.

German North Polar. — Die zweite deutsche Nordpolarfahrt in 1869 und 1870.

Fishes, W. C. H. Peters, 1874.1.

German South Polar. — Die deutsche Südpolar-Expedition, 1901–03.

Fishes, P. Pappenheim, 1912.1, 1914.1; L. Lampe, Add. 1914.1.

"Golden Crown." — Expeditions of the government of Bengal's steam trawler "Golden Crown" [in the Bay of Bengal].

Fishes, B. L. Chaudhuri, 1908.2; A. Ahmad, 1911.1; J. T. Jenkins, 1910.2–1912.1; N. Annandale, 1909.1, 1910.1; N. Annandale & J. T. Jenkins, 1910.1.

Gruvel. — Missions Gruvel sur la côte occidentale d'Afrique (1905–12).

Fishes, J. Pellegrin, 1914.2.

Hamberg Magellan. — Die Hamburgische magelhaenische Sammelreise, 1892–93.

Fishes, E. Lönnberg, 1907.1.

"Herald." — The voyage of H.M.S. "Herald" during . . . 1845–51 . . . around the globe and in the Arctic Ocean.

Fishes, J. Richardson, 1854.1.

"Hirondelle." — [Expeditions to the Azores and Canary Islands in 1885–88 by the Prince of Monaco in his yacht "Hirondelle."]

Fishes, R. Collett, 1889.1, 1896.2. Other accounts, under Albert I (Prince of Monaco).

"Hirondelle II." — Campagnes du yacht "Hirondelle II," 1911–13.

Fishes, E. Zugmayer, 1913.2, 1914.1.

Hopkins-Stanford. — The Hopkins-Stanford Galapagos Expedition, 1898–99.

Fishes, R. E. Snodgrass & E. Heller, 1903.1, 1905.1, 1906.1.

Howgate. — [The Howgate polar expedition to Arctic America, 1877–78.]

Fishes, T. H. Bean, 1879.1.

Indiana-Carnegie. — Expedition to British Guiana of Indiana University and the Carnegie Museum, 1908.

Fishes, C. H. Eigenmann, 1909.4, 1912.2.

Indo-China. — Mission Pavie Indo-Chine, 1879–95.

Fishes, L. L. Vaillant, 1892.2,.5, 1901.2.

"Ingolf." — Danske "Ingolf"-Expedition [to the north Atlantic].

Fishes, H. F. Jungersen, 1898.1, 1899.1, 1905.1; C. F. Lütken, **1898.1**.

"Investigator." — [Cruises of H. M. Indian marine surveying steamer "Investigator" in the Bay of Bengal.]

Fishes, A. Alcock, 1889.1–**1899.1**, 1901.1–1905.1; A. Alcock & A. C. McGilchrist, 1892.1; A. F. McArdle, 1901.1; R. B. Seymour-Sewell, 1912.1, 1913.1.

"Lady Franklin" and "Sophia." — Voyage in Baffin's Bay and Barrow Straits in . . . 1850–51, performed by H.M.S. "Lady Franklin" and "Sophia."

Fishes, P. C. Sutherland, 1852.1.

"La Manche." — Voyage de "La Manche" à l'île Jan-Mayen et au Spitzberg, 1892.

Fishes, L. L. Vaillant, 1894.1.

"Magenta." — Viaggio . . . al globo della . . . "Magenta" durante . . . 1863–68.

Zoology, A. Targioni-Tozzetti, 1877.1.

Mexico and **Central America.** — Mission scientifique au Mexique et dans l'Amérique centrale.

Fishes, L. L. Vaillant & F. Boucourt, 1874.1.

"Michael Sars." — The "Michael Sars" north Atlantic deep sea expedition, 1910 . . . under Sir John Murray and Dr. Johann Hjort.

Fishes, E. Collett, 1909.1; E. Lea, Add 1913.1 (Murænoid larvæ). Report on expedition, E. Lea, 1913.2.

Moluccas and **Borneo.** — Eine zoologische Forschungsreise in den Molukken und Borneo . . . von W. Kukenthal.

Fishes, F. Steindachner, 1903.1.

New Guinea. — Nova Guinea . . . l'expédition . . . Néerlandaise à la Nouvelle-Guinée en 1903 [1907 et 1909] sous . . . Arthur Wichmann.

Fishes, M. Weber, 1908.1, 1913.3.

New Zealand. — New Zealand government trawling expedition, 1907.

Fishes, E. R. Waite, 1909.1.

Norwegian North Atlantic. — Den Norske Nordhavs-Expedition, 1876–78.

Fishes, R. Collett, 1878.1,.2, **1880.1**,.4.

"Novara." — Reise der oesterreichischen Fregatte "Novara" um die Erde, in . . . 1857–59, unter . . . Commodore B. von Wüllerstorf-Urbair.

Fishes, R. Kner, 1864.4, 1865.3. Narrative, etc., B. von Wüllerstorf-Urbair, 1861.1.

"Olga." — Eine Untersuchungsfahrt [der "Olga,"] nach der Bäreninsel und Westspitzbergen [im Jahre 1898].

Fishes, E. Ehrenbaum, 1905.1.

Orbigny. — Voyage dans l'Amérique méridionale . . . pendant . . . 1826–33, par A. d'Orbigny.

Fishes, A. Valenciennes, 1847.2.

Peary. — Peary auxiliary expedition of 1894.

Fishes, O. Holmquist, 1899.1.

—— Peary relief expedition of 1899.

Fishes, H. W. Fowler, Add. 1914.3.

Przewalski Central Asian. — Die von N. M. Przewalski nach Central-Asien unternommene Reise.

Fishes, S. M. Herzenstein, 1888.1.

"Princesse Alice." — [The explorations of Albert I of Monaco in the "Princesse Alice" in the Mediterranean Sea and the eastern Atlantic, 1901–10.]

Fishes, J. Richard, 1905.1; E. Zugmayer 1911.1,.2. Narrative, etc., Albert I (Prince of Monaco) 1896.1, 1904.1, 1906.1, Add. 1895.1

Princeton Patagonian. — The Princeton University expeditions to Patagonia, 1896–99.

Fishes, C. H. Eigenmann, 1909.3, 1910.1.

"Samarang." — The voyage of H.M.S. "Samarang" [in eastern seas], under . . . Captain E. Belcher, during 1843–46.

Fishes, J. Richardson, 1848.1. Smaller papers, A. Adams, 1850.1–1863.1, Add. 1864.1.

Schomburgk, (R. H.). — R[obert] H[ermann] Schomburgk's Reisen in Guiana und am Orinoko während . . . 1835–39.

Fishes, R. H. Schomburgk, 1841.1.

Schomburgk, (M. R.). — Reisen in Britisch-Guiana in . . . 1840–44 . . . von M[oritz] R[ichard] Schomburgk.

Fishes, J. Müller & F. H. Troschel, 1848.1.

"Scotia." — The Scottish National Antarctic Expedition [in the "Scotia"] . . . 1902–04 . . . under W. S. Bruce.

Fishes, R. S. Clark, 1912.1, 1913.1; L. Dollo, 1906.2–1909.3; C. T. Regan, **1913.1.** Narrative, etc. T. Wilton, 1908.1; W. S. Bruce, Add. 1914.1.

Semon. — Zoologische Forschungsreisen in Australien und dem malayischen Archipel . . . 1891–93 von Dr. Richard Semon.

Fishes, R. W. Semon, 1893.1–1908.1; M. Weber, 1895.2. Narrative, R. W. Semon, 1896.2, 1899.1, 1903.2; W. B. Spencer, 1898.1.

"Siboga." — Siboga-Expeditie . . . in nederlandsch Oost-Indië, 1899–1900.

Fishes, M. Weber, 1909.1, **1913.1**; narrative, 1901.2.

South Australian. — South Australian government trawling cruise, 1914.

Fishes, E. R. Waite & A. R. McCulloch, 1915.1.

"Southern Cross." — [Voyage of the "Southern Cross" into the Antarctic regions in 1908–09.]

Fishes, G. A. Boulenger, 1902.30.

Spix and **Martius.** — Reise in Brasilien . . . 1817 bis 1820 gemacht . . . von J. B. von Spix und C. F. P. von Martius.

Fishes, J. B. von Spix & L. Agassiz, 1829.1. Narrative, J. B. von Spix & C. F. P. von Martius, 1823.1, 1824.1.

Stanford. — The Stanford expedition to Brazil in 1911.

Fishes, E. C. Starks, 1913.1.

"Sulphur." — The . . . voyage of H. M. S. "Sulphur" [around the world] under . . . Capt. Sir Edward Belcher, during . . . 1836–42.

Fishes, J. Richardson, 1844.5.

Sunda. — Die Sunda-Expedition des Vereins für Geographie und Statistik zu Frankfort-am-Main.

Fishes, C. M. Popta, 1912.2,.3.

Swedish Arctic. — The Swedish Arctic expedition to Spitzbergen and King Charles Land, 1898.

Fishes, E. Ehrenbaum, 1901.2; E. Lönnberg, 1899.5.

Swedish Magellan. — Die schwedische Expedition nach den Magellansländern, 1895–97.

Fishes, F. A. Smitt, 1897.1.

Swedish South Polar. — Die schwedische Südpolar Expedition, 1901–03, unter . . . Dr. O. Nordenskiold.

Fishes, E. Lönnberg, 1905.3.

"Terra Nova." — British antarctic ("Terra Nova") expedition, 1910.

Fishes, C. T. Regan, 1914.1,.4, 1916.3.

Tanganyika. — [Expeditions to Lake Tanganyika — I, 1895–96; and

II, 1899–1900, by J. E. S. Moore: and III, 1904–1905, by W. A. Cunnington.]

Fishes, G. A. Boulenger, 1898.15, 1900.8, 1901.10,.23, 1906.6.

Thayer. — [The Thayer expedition to Brazil under Louis Agassiz, 1865–66.]

Fishes, C. H. Eigenmann, 1908.1. Narrative, Prof. L. and Mrs. E. C. Agassiz, 1868.1.

Prof. Eigenmann has issued several papers since 1914 on the fishes collected by this expedition.

" Thetis." — Trawling operations off the coast of New South Wales . . . by H.M.C.S. " Thetis."

Fishes, E. R. Waite, 1898.1,.2, **1899.4**, 1900.3.

Tilho. — Mission Tilho [au Lac Tchad] (1906–09).

Fishes, J. Pellegrin, 1914.3.

" Travailleur " and **" Talisman."** — Expéditions scientifiques du " Travailleur " et du " Talisman " [autour du monde] pendant, 1880–83.

Fishes, L. L. Vaillant, **1888.2**. General accounts, E. L. Bouvier, 1890.1; H. Filhol, 1884.1, 1885.1.

United States Naval. — The United States naval astronomical expedition to the southern hemisphere [Chile], during . . . 1849–52.

Fishes, C. Girard, 1855.1, 1856.1.

" Uranie " and **" Physicienne "** — Voyage autour du monde . . . sur " L'Uranie " et " La Physicienne," pendant, 1817–20.

Fishes, J. R. C. Quoy & P. Gaimard, 1824.1, .2,.3.

" Valdivia." — Die deutsche Tiefsee-Expedition auf dem . . . " Valdivia " 1898–99.

Fishes, A. Brauer, 1902.1–1908.1. General reports on results, C. Chun, 1897.2–1908.1.

" Vénus." — Voyage autour du monde sur la . . . " Vénus," pendant . . . 1836–39, commandée par A. du Petit-Thouars.

Fishes, A. Valenciennes, Add. 1855.1.

" Violante." — Le crociere del " Violante " [nel Mediterraneo].

Fishes, D. Vinciguerra, 1883.2.

Werner. — Zoologische Forschungsreise Dr. Franz Werner's nach dem ägyptischen Sudan und Nord-Uganda.

Fishes, F. Werner, 1906.1.

Wilkes. — United States exploring expedition into the South Seas, 1838–42 [under Capt. C. Wilkes].

Fishes of the Pacific slope of North America, L. Agassiz, 1855.1. Narrative, C. Wilkes, Add. 1845.1.

" Wodan." — [Expeditions of the " Wodan " in the North Sea, 1902–11.]

Fishes, H. C. Redeke, 1911.3.

" Woy Woy." — The expedition of the " Woy Woy " in the Tasman Sea.

Fishes, A. R. McCulloch, 1907.1.

Yarkand. — [The first Yarkand expedition of the government of India, 1873].

Fishes, F. Day, 1876.3.

—— [Second Yarkand mission of the government of India.]

Fishes, F. Day, 1878.5.

VI

PERIODICALS RELATING TO FISH AND FISH-CULTURE, WITH THE ABBREVIATIONS HEREIN USED.[1]

Aarsber. Vedkom. Norges Fiskerier. — Aarsberetning Vedkommende Norges Fiskerier. Christiana, 1882; Bergen, 1900. Current.

Abh. Deutsch. Seefischerei-Ver. — Abhandlungen des Deutschen Seefisherei-Vereins. Berlin, 1897–1913. Current (?).

Acquicolt. Lombard. — L'Acquicoltura Lombarda. Milano, 1899–1905. 7 vols.

Next as "Rev. Mens. Pesca," Milano. (q. *v.*).

Allg. Fisch.-Zeitg. — Allgemeine Fischerei-Zeitung. München, 1886 to date. Current.

Continuation of "Bayerische Fischereizeitg." (*q. v.*).

Amer. Angler. — The American Angler. New York, 1881–1900. 30 vols.

Merged in 1900 into "Field & Stream."

Amer. Fish Cult. — The American Fish Culturist. St. Johnsbury, Vt., 1904–05. 2 vols.

Merged with "Field & Stream," 1905.

Ann. Stat. Aquic. Boulogne-sur-Mer. — Annales de la Station Aquicole de Boulogne-sur-Mer. Boulogne-sur-Mer, 1892–1912. Ceased(?).

Ann. Rept. Comm. Fisheries of N. Y. — Annual Report of the Commissioners of Fisheries of the State of New York. 1869–94.

Title varies. Next as:

Ann. Rept. Comm. Fish. Game & Forests of N. Y. Annual Report of the Commissioners of Fisheries, Game and Forests of the State of New York. 1895–99. Next as:

Ann. Rept. Forest, Fish & Game Comm. of N. Y. — Annual Report of the Forest, Fish and Game Commission of the State of New York. 1900 to date. Current.

Ann. Rept. Comm. Fisheries Indiana. — Annual Report of the Commissioner of Fisheries of Indiana. 1882–83.

Afterwards "Bienn. Rept.," etc. (*q. v.*).

Ann. Rept. Comm. Inland Fisheries Rhode Island. — Annual Report of the Commissioners of Inland Fisheries of the State of Rhode Island. 1871 to date. Current.

Ann. Rept. Dept. Marine & Fisheries Canada. — Annual Report of the Department of Marine and Fisheries of Canada. 1868 to date. Current.

Ann. Rept. Fish. Board Scotland. — Annual Report of the Fishery Board for Scotland. 1882 to date. Current.

See also "Rept. Fishery Board Scotland. Sci. Invest.," and *ditto*, "Salmon Fisheries."

An. Com. Perm. Pesca. — Anuario Comision Permanente de Pesca. Madrid, 1868–69. 2 vols. All published.

Arbeit. Ichthyol. Lab. Kasp. Fisch.-Verwalt. — Arbeiten des Ichthyologischen Laboratorium der Kaspi-Volgaschen Fischerei-Verwaltung in Astrachan. [Text in Russian] 1909–13. Ceased (?).

Arch. Fischereigesch. — Archiv für Fischereigeschichte. Darstellungen und Quellen. Berlin, 1913–17. Current (?).

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[1] A list of the chief periodicals on these subjects, with places and years of publication so far as ascertained. The articles ("a," "an," and "the") in English and other languages are disregarded in alphabetizing.

The abbreviations are placed first in order that this section may serve as a finding list for the full titles.

Bayerische Fischerei-Zeitg. — Bayerische Fischerei-Zeitung. München, 1879–85. 7 vols.

In 1885 name changed to "Allg. Fisch.-zeitg." (*q. v.*).

Bericht Fischerei-Ver. Prov. Ostpreuss. — Bericht des Fischerei-Vereins für die Provinz Ostpreussen. Königsberg, 1876 to date. Current.

Bienn. Rept. Comm. Fisheries California. — Biennial Report of the Commissioners of Fisheries of the State of California. 1870–84. Title varies.

Bienn. Rept. State Board Fish Comm. California. — Biennial Report of the State Board of Fish Commissioners for the State of California. 1885 to date. Current.

Bienn. Rept. Comm. Fisheries & Game Indiana. — Biennial Report of the Commissioner of Fisheries and Game of Indiana. 1884 to date. Current.

First as "Ann. Rept.," etc. (*q. v.*).

Bienn. Rept. State Board Fish. Comm. Michigan. — Biennial Report of the State Board of Fish Commissioners of Michigan. 1873 to date. Current.

Blätt. Aquar. Terrar. Freunde. — Blätter für Aquarien- und Terrarienfreunde. Magdeburg, 1890–95.

Apparently changed title to:

Blätt. Aquar. Terrar. Kunde. — Blätter für Aquarien- und Terrarienkunde. Stuttgart, 1890–1914. Ceased (?).

Bohuslänsk Fiskerit. — Bohuslänsk Fiskeritidsskrift. Göteborg, 1884–96. 12 vols.

Boletin Bosques, Pesca i Caza. — Boletin de Bosques, Pesca i Caza. Santiago, Chile, 1912–15. Current (?).

Boll. Soc. Lombarda Pesca Acquicoltura. — Bolletino Mensile della Società Lombarda per la Pesca e l'Acquicoltura. Milano, 1908 to date. Current.

Bull. Ill. State Lab. Nat. Hist. Bulletin of the Illinois State Laboratory of Natural History. 1884 to date. Current.

Bull. Mich. State Board Fish Comm. — Bulletin of the State Board of Fish Commissioners of Michigan.

Issued at irregular intervals with the "Bienn. Rept." (*q. v.*).

Bull. Pêches Marit. — Bulletin des Pêches Maritimes Annexe de la Revue Maritime et Coloniale. Paris, 1893–98. 6 vols.

Vol. I entitled "Revue Maritime et Coloniale. Section Pêches."

Bull. Piscicult. Prat. — Bulletin de Pisciculture Pratique. Paris, 1888–90. 3 vols.

Continued as "Etangs et Rivières." (*q. v.*).

Bull. Pop. Piscic. Amél. Pêche. — Bulletin Populaire de la Pisciculture et des Améliorations de la Pêche. Paris, 1907–14. Ceased (?).

Bull. Soc. Centr. Acquicult. Pêche. — Bulletin de la Société Centrale d'Acquiculture et de Pêche. Paris, 1888–1914. Ceased (?).

Bull. Soc. Imp. Zool. Acclimat. — Bulletin de la Société Imperiale Zoologique d'Acclimatation de France. 1854–71.

Title varies. Next as:

Bull. Soc. Acclimat. — Bulletin de la Société d'Acclimatation de France. Paris, 1872–81. Finally as:

Bull. Soc. Nat. Acclimat. — Bulletin de la Société Nationale d'Acclimatation de France. Paris, 1882 to date. Current.

Bull. Station Piscicult. — Bulletin de la Station de Pisciculture et Hydrobiologie de l'Université de Toulouse. 1903–(?).

Bull. Suisse Pêche Piscicult. — Bulletin Suisse de Pêche et Pisciculture. Neuchâtel, 1900 to date. Current.

Bull. Trim. Enseign. Prof. Tech. Pêches Marit. — Bulletin Trimestriel de l'Enseignements Professionels et Techniques de Pêches Maritimes. Paris, 1895–(?).

Bull. U. S. Fish Comm. — Bulletin of the United States Fish Commission. Washington, 1881–1903, vols. 1–23.

Beginning with 1904, title is:

Bull. [U. S.] Bur. Fisheries. Bulletin of the [United States] Bureau of Fisheries. Washington, 1904, vol. 24, to date. Current.

Circul. Deutsch. Fischerei Ver. — Circulare des Deutschen Fischerei-Vereins. Berlin, 1871–92.

Conseil Perm. Intern. Explor. Mer. Rapp. & Proc. Ver. — Conseil

Permanent International pour l'Exploration de la Mer. Rapports et Procès-Verbaux des Réunions. 1902 to date. Current.

Copeia. (Not abbreviated.) New York, 1913 to date. Current.

Dansk Fiskerit. Dansk Fiskeritidende . . . Medlemsblad for Dansk Fiskeriforening. Kjøbenhavn, 1891–1918. Current.

Apparently began publication, Helsingør, 1891. Ny Raekke, Copenhagen, 1903–1918, vols. 1–15.

Deutsche Fischerei-Korresp. — Deutsche Fischerei-Korrespondenz. Köln (afterwards Bonn), 1897–1915. Ceased (?).

Deutsch. Fischerei-Zeitg. — Deutsche Fischerei-Zeitung. Wochenblatt für See- und Binnenfischerei, etc. Stettin, 1878 to date. Current.

Dneven. Otd. Icht. Imp. R. Obšč. Acclim. — Journal de la Section Ichthyologique de la Société Impériale Russe d'Acclimatation des Plantes et des Animaux. Moscou, 1883 (?)—(?).

Same as "Trd, Otd. Ichthiol. Obšč. Acclim." (*q. v.*).

Etangs et Rivières. (Not abbreviated). Paris, 1891–98. 8 vols.

Continuation of "Bull. Piscicult. Prat." (*q. v.*).

Ferskvandsfiskeribladet. — Ferskvandsfiskeribladet. Dansk Ferskvandsfiskeriforenings Medlemsblad. Kolding, 1906–1912. Current (?).

Field and Stream. (Not quoted by us.)

Formed by mergers of "Amer. Angler" and "Amer. Fish Cult." (*q. v.*).

Finlands Fiskerier. — (Not abbreviated.) Helsingfors, 1912 to date. Current.

Der Fischerbote. — Der Fischerbote. Zeitschrift für . . . Hochsee-Küsten- und Flussfischerei, etc. Hamburg, 1910 to date. Current.

Fischerei-Zeitg. — Fischerei-Zeitung. Wochenschrift für . . . Binnenfischerei, etc. Neudamm, 1898 to date. Current.

Fisheries Scotland Sci. Invest. — Fishery Board for Scotland. Scientific Investigations. 1909 to date. Current.

One of the subsidiary parts of the "Ann. Rept. Fish. Board Scotland." (*q. v.*).

Fish. Gazette. — Fishing Gazette, etc. London, 1865 to date. Current.

Fish. Ireland Scient. Invest. — Scientific Investigations. Part II of Report Sea and Inland Fisheries of Ireland. (*q. v.*).

Fiskeritidskr. Finland. — Fiskeritidskrift för Finland. Utgifna af Fiskeriförening. Helsingfors, 1892 to date. Current.

Forest & Stream. — (Not abbreviated.) New York, 1874 to date. Current.

Gyogaku Zasshi. — (Not abbreviated.) (Journal of Ichthyology.) 1914 to date. Current.

Intern. Rev. Ges. Hydrobiol. & Hydrog. — International Revue der Gesammten Hydrobiologie und Hydrographie. Leipzig, 1908 to date. Current.

Jahresber. Rhein. Fischerei-Ver. — Jahresbericht des Rheinischen Fischerei-Vereins. Bonn, 1888–1909.

Jahresb. Schles. Fischerei-Ver. — Jahresbericht des Schlessischen Fischerei-Vereins. Breslau, 1899(?)–1911(?).

Journ. Imp. Fish. Bureau. — Journal of the Imperial Fisheries Bureau. Tokyo, 1892 to date(?). Current(?).

Nearly all articles in Japanese.

Journ. Nat. Fish Cult. Assoc. — Journal of the National Fish Culture Association. London, 1887. 2 vols.

Journ. Mar. Biol. Assoc. — Journal of the Marine Biological Association of the United Kingdom. Plymouth, 1887 to date. Current.

Korrespbl. Fischzucht. — Korrespondenzblatt für Fischzüchter. Berlin, 1893 to date. Current.

Meddel. Komm. Havundersørgelser. Ser. Fiskeri. — Meddelelser fra Kommission for Havundersørgelser. Series Fiskeri. Kjøbenhavn, 1904 to date. Current.

Meddel. Norske Jæger & Fisker. Forening. — Meddelelser fra Norske Jæger og Fisker-Forening. Kjøbenhavn, 1872–80. 9 vols.

Meded. Visch. — Mededeelingen over Vischerij. Helder, 1884 to date. Current.

Meded. Vischerijstation. — Mededeelingen van het Vischerij Station te Batavia. Buitenzorg, 1908 to date(?). Current(?).

Medlemsbl. Dansk Fiskeriforen. — Medlemsblad for Dansk Fiskeriforening. Copenhagen.

Secondary title for "Dansk Fiskerit." (*q. v.*).

Mitth. Deutsch. Seefischerei-Ver. — Mittheilungen des Deutschen Seefischerei-Vereins. Berlin, 1885 to date. Current.

Mitth. Fischerei-Ver. Prov. Brandenburg. — Mittheilungen des Fischerei-Vereins für die Provinz Brandenburg. Berlin, 1908–14. (Ceased?).

Mitth. Fischereiwesen. — Mittheilungen über Fischereiwesen. München, 1876–78. 3 vols.

Continued as "Bayerische Fischerei-Zeitg." 1879–85. (*q. v.*).

Mitth. Westpreussischen Fischerei-Ver. — Mittheilungen des Westpreussischen Fischerei-Vereins. Danzig, 1888 to date. Current.

Natur u. Haus. — Natur und Haus. Illustrierte Zeitschrift für alle Liebhaber im Reiche der Natur. Berlin, later Stuttgart, then Dresden, 1892 to date. Current.

Neptunia. — Neptunia. Revista Italiana di Pesca ed Agricultura. Venezia, 1897 to date. Current. (2 vols. per year.)

Nordisk Aarsskr. Fiskeri. — Nordisk Aarsskrift for Fiskeri. Kjøbenhavn, 1884–87.

Continuation of "Nordisk Tidsskr. Fiskeri." (*q. v.*).

Norsk Fiskerit. — Norsk Fiskeritidende. Udgivet ved Selskabet for de Norske Fiskeriers Fremme. 1882 to date. Current.

Nordisk Tidsskr. Fiskeri. — Nordisk Tidsskrift for Fiskeri. Kjøbenhavn, 1874—83. 10 vols.

Continuation of "Tidsskr. Fiskeri" (*q. v.*), and in turn continued as "Nordisk Aarsskr. Fiskeri." (*q. v.*).

Oesterreich. Fisch.-Zeitg. — Oesterreichische Fischerei-Zeitung . . . Zeitschrift der K. K. Oesterreichischen Fischerei-Gesellschaft. Wien, 1904 to date. Current.

Pisciculture Pratique. — La Pisciculture Pratique. Bulletin des Sociétés de Pêche et de Pisciculture de France. Paris, 1897–1900. Ceased.

Proc. Amer. Fish Cult. Assoc. — Proceedings of the American Fish Culturists' Association. 1870–75.

Appeared next as "Trans.," etc. (*q. v.*).

Proc. Central Fishcult. Soc. — Proceedings of the Central Fishcultural Society. Chicago, 1879–80.

Ceased publication. Above reprinted from "Forest & Stream."

Proc. Trans. Liverpool Biol. Soc. — Proceedings and Transactions of the Liverpool Biological Society. 1886 to date. Current.

Rept. Comm. Fisheries Mass. — Report of the Commissioners of Fisheries of the Commonwealth of Massachusetts. 1867–70.

Title varies. Next as:

Rept. Comm. Inland Fisheries. Mass. — Report of the Commissioners of Inland Fisheries of . . . Massachusetts. 1871–86. Next as:

Rept. Comm. Inland Fisheries and Game Mass. — Report of the Commissioners of Inland Fisheries and Game of . . . Massachusetts. 1887–1902. Then as:

Rept. Comm. Fisheries & Game Mass. — Report of the Commissioners of Fisheries & Game of Massachusetts. 1903 to date. Current.

Rept. Fishery Board Scotland. Salmon Fisheries. — Report of the Fishery Board for Scotland. Salmon Fisheries. 1882 to date. Current.

One of the component parts of "Ann. Rept. Fish. Board Scotland." (*q. v.*).

Rept. Fisheries New South Wales. — Report of the Commissioners of Fisheries of New South Wales. 1879 to date. Current but irregular.

Rept. Danish Biol. Sta. — Report of the Danish Biological Station. Copenhagen, 1890 to date. Current.

Rept. Dove Marine Laby. — Report of the Dove Marine Laboratory, Cullercoats, Northumberland. 1912 to date. Current.

Succeeds "Rept. Northumberland Sea Fish. Comm." (*q. v.*).

Rept. Fishery Board Scotland. Sci. Invest. — Report Fishery Board for Scotland. Scientific Investigations. 1887 to date. Current.

One of the sections of "Ann. Rept. Fish. Board Scotland." (*q. v.*).

Rept. Imp. Fish. Bur. — Report of the Imperial Bureau of Fisheries. Tokyo, 1912 to date. Current.

Rept. Lancashire Sea-Fish. Labor. Reports of the Lancashire Sea-Fisheries Laboratory. Liverpool, 1893 to date. Current.

Rept. Sea Inland Fish. Ireland. — Report on the Sea and Inland Fisheries of Ireland. 1868 to date. Current.

Rept. Sea Inland Fish. Ireland. Sci. Invest. — Report of the Sea and Inland Fisheries of Ireland. Scientific Investigations. 1901 to date. Current.

One of the component parts of the preceding.

Rept. Northumberland Sea Fish. Comm. — Report on the Scientific Investigations, Northumberland Sea-Fisheries Committee. 1896–1911.

Succeeded by "Rept. Dove Marine Laby." (*q. v.*).

Rept. State Comm. Fisheries Pa. — Report of the State Commissioners of Fisheries of Pennsylvania. 1870–1902.

Title varies. Next as:

Rept. Dept. Fisheries Pennsylvania. — Report of the Department of Fisheries of the Commonwealth of Pennsylvania. 1903 to date. Current.

Rept. U. S. Fish Comm. — Report of the United States Commissioner of Fish and Fisheries. Washington, 1881–1903.

Title changed. Next as:

Rept. U. S. Comm. Fisheries.— Report of the Commissioner of [the U. S. Bureau of] Fisheries. Washington, 1904 to date. Current.

Rev. Intern. Pêche Piscicult. — Revue Internationale de Pêche et de Pisciculture. Société Impériale Russe de Pêche et Pisciculture. St. Petersburg, 1899–(?).

Rev. Mens. Pesca. — Revista Mensile di Pesca. Milano, 1898(?) — 1911. Ceased(?).

Successor to "Acquicolt. Lombard.," 1906. (*q. v.*).

Rev. Mens. Pesca Idrobiol. — Revista Mensile di Pesca e Idrobiologia. Pavia, 1895–1917.

Schweiz. Fisch.-Zeitg. — Schweizerische Fischerei-Zeitung. Zurich, 1892 to date. Current.

Skrift. Udgivn. Komm. Havundersøgelser. — Skrifter Udgivna af Kommissionen for Havundersøgelser. Kjøbenhavn, 1903 to date. Current.

Skrift. Södra Sveriges Fiskerifören. — Skrifter Utgivna av Södra Sveriges Fiskeriförening. 1906(?) to date(?). Current(?).

Soc. Imp. Russe Pêche Piscicult. — Société Impériale Russe de Pêche et Pisciculture. St. Petersburg, 1899–(?).

See also under "Rev. Intern. Pêche Piscicult."

Svensk Fiskeritidsskr. — Svensk Fiskeritidsskrift. Stockholm, 1892 to date. Current.

Tidsskr. Fiskeri. — Tidsskrift for Fiskeri. Kjøbenhavn, 1866–73. 7 vols.

Continued as "Nordisk Tidsskrift for Fiskeri." (*q. v.*).

Tidsskr. Jägare & Fisk. — Tidsskrift för Jägare och Fiskare. Helsingfors, 1893–1914. Current(?).

Trans. Amer. Fish Cult. Assoc. — Transactions of the American Fish Cultural Association. 1876–84.

First appearing as "Proc.," etc. (*q. v.*); next as:

Trans. Amer. Fisheries Soc. — Transactions of the American Fisheries Society. 1885 to date. Current.

For earlier parts, *see* under "Trans. Amer. Fish. Cult. Assoc.," and "Proc. Amer. Fish. Cult. Assoc."

Trans. Pacific Fisheries Soc. — Transactions of the Pacific Fisheries Society. 1914–15. 2 vols. All published.

Trd. Otd. Ichthiol. Obšč. Akklim. — "Trudy" (Trudui) of the Ichthyological Section of the Imperial Russian Society of Animal and Plant Acclimatization. [Text in Russian] Moskva, 1883–(?).

See also "Dneven. Otd. Icht. Imp. R. Obšč. Acclim."

Verhand. Rapp. Rijksinstit. Vischerionderzoek. — Verhandelingen en Rapporten uitgeven door de Rijksinstituten voor vischerionderzoek. 's Gravenshage, 1913 to date. Current.

Verh. Rijksinstit. Onderz. Zee. — Verhandeling uit het Rijksinstituut voor het Onderzoek der Zee. Helder, 1906. Irregular, but probably current.

Vischereijcourant. — Nederlandsche Vischerijcourant. Haarlem, 1902–1905. 3 vols.

Wiss. Meeresuntersuch. — Wissenschaftliche Meeresuntersuchungen. Kiel, 1894 to date. Current.

Wochenschr. Aquar. Terrar. Kunde. — Wochenschrift für Aquarien- und Terrarienkunde. Braunschweig, 1903 to date. Current.

Zeitschr. Akklimat. — Zeitschrift für Acclimatization. Berlin, 1858–74.

Zeitschr. Fisch. Hilfsw. — Zeitschrift für Fischerei und deren Hilfswissenschaften. Berlin, 1893 to date. Current.

VII

ERRATA AND CORRIGENDA[1]

A., *H.* 1883.1, p. 1, correctly cited as H., A. 1883.1, p. 530.

Abt, *F. N.* 1789.1, p. 3, correctly cited as Ahl, J. N. 1789.1, p. 14.

Agassiz, *A.* 1865.1,.2,.3, p. 6, correctly cited under Agassiz, J. L. 1865.2, p. 13; — 1872.1, p. 6, correctly cited as Agassiz, J. L. 1871.1, p. 13.

Agassiz, *J. L.* 1835.3, p. 8, included in 1834.3; — 1835.4, p. 8, included in 1834.1; — 1840.2, p. 8, included in 1840.4; — 1844.4, p. 8, included in 1843.2; — 1844.10, p. 9, included in 1843.2; — 1856.6, p. 12, correctly cited as 1856.11; — 1858.6, p. 12, correctly cited as 1858.8; — 1858.10, p. 12, correctly cited as 1858.9.

Anderson, *R. J.* 1904.1, p. 26, not on fishes.

Antwerp, *W. van,* 1883.1, p. 30, better cited as Van Antwerp, W. 1883.1, vol. II, p. 577.

Arendsen Hein, *S. A.* 1913.1, p. 32, better cited as Hein, S. S. A. 1913.2, p. 559.

Artaud, *J. B. L.* 1821.1, p. 37 (second entry), same as 1821.1 preceding or first entry.

Aukarsvärd, *G.* & **Hammer,** *J. Aug.* 1913.1, p. 43, correctly cited as Ankarsvärd, G. & Hammar, J. A. 1913.1, p. 29.

B. 1895.1, p. 47, correctly cited as **Benecke,** *B.* 1895.1, p. 97.

B., *B.* 1877.1, p. 47, correctly cited under Bocage, J. V. 1878.1, p. 140.

Bacounin, ——, 1789.1, p. 48, not a fish.

Baldaque da Silva, *A.* 1891.1, p. 61, better cited as Silva, A. B. da., 1892.1, vol. II, p. 449.

Balfour, *F. M.* 1878.2, p. 61, correctly cited as Balfour, F. M. 1876.2, p. 61.

Balfour, *W.* 1852.1,.2, 1853.1, p. 62, correctly cited as Baikie, W. B(alfour) Add. 1852.1,.2, 1853.1.

Baluchin, ——, 1877.1, p. 65, correctly cited as Babukin, A. I. 1877.1, p. 48.

Bataillon, *E.* 1893.1, p. 73, correctly cited as Bataillon, E. & Dubard, —. 1895.1, p. 74.

Bayliss, *W. M.* & **Staring,** *E. H.* 1903.1, p. 78, contains no fishes.

Bean, *B. A.* 1908.1, p. 80, correctly cited as Bean, B. A. Add. 1899.1.

Bean, *T. H.* 1905.1, p. 87, correctly cited as Bean, T. H. 1903.1, p. 87.

Beaufort, *L. de,* 1912.2, p. 91, correctly cited as Weber, M. & Beaufort, L. de, 1912.3, vol. II, p. 610.

Beecher, *C. E.* 1898.1, p. 93, contains no fishes.

Beguis, *J. M.* 1882.1, p. 93, correctly cited as Reguis, J. F. 1882.1, vol. II, p. 327.

Belotti, *C.* 1890.1, p. 96, not a fish.

Bender, *O.* 1910.1, p. 96, not on fishes.

Berg, *L. S.* 1908.1, p. 102, probably same as Berg, L. S. & Kouznetzoff, I. D. 1908.1, p. 104; — 1913.9, p. 104, correctly cited as Berg, L. S. 1912.5, p. 103.

Bernard de Reste, *C.* 1791.1, p. 105, preferably cited as Reste, B. de, 1801.1, vol. II, p. 336.

Binney, *W. G.* 1842.1, p. 112, correctly cited as Binney, A. 1842.1, p. 112.

Bishop, *Harman N.* 1899.1, p. 113, correctly cited as Harman, B(ishop) N. 1899.1, p. 543.

Bleeker, *P.* 1857.11, p. 125, correctly cited as Bleeker, P. 1854.14, p. 122.

Bohn, *G.* 1907.1, p. 145, not on fishes.

Boll, *E.* 1858.1, p. 147, correctly cited as Boll, E. F. Add. 1868.1.

Bonaparte, *C. L.* 1833.1, p. 148, correctly cited as Bonaparte, C. L. Add. 1833.1.

Books, *St. John,* 1893.1, p. 151, correctly cited as Brooks, H. St. John, 1885.1, p. 187.

Bothe, *A.* 1899.1, p. 158, correctly cited as Bethe, A. 1899.1, p. 108.

Bottemanne, *C. J.* & **Hock,** *P. P.*

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[1] In order to correct the errors in the preceding parts of this Bibliography, these authors or titles, unless corrections are here indicated, should be deleted.

Where no author is named in giving the correct citation, the original author is understood.

For an explanation of the principles involved in the compilation of this section, *see* the preface.

1888.1, p. 158, correctly cited as Hoek, P. P. & Bottemanne, C. J. 1888.1, p. 588.

Boudouy, *T.*, p. 159, should be Bondouy, T., p. 149. The name of this author prefixed to his articles has appeared both as *Boudouy* and *Bondouy*, the latter, however, is correct.

Boulenger, *E. G.* 1913.1, p. 159, correctly cited as Boulenger, C. L. 1913.1, p. 159.

Boulenger, *G. A.* 1897.11, p. 162, correctly cited as 1898.12, p. 162; — 1898.6, p. 162, same as 1902.19, p. 166; — 1898.10, p. 162, included in 1895.8, p. 161; — 1900.16, p. 164, same as 1899.11, p. 163; — 1902.13, p. 166, correctly cited as 1901.8, p. 164; — 1912.3, p. 170, correctly cited as 1912.4, p. 170.

Bourne, *R. H.* 1898.1, p. 172, correctly cited as Burne, R. H. 1898.1, p. 204.

· **Boutan,** *L.* & **Racovitza,** *E. P.* 1895.1, p. 172, not on fishes.

Branca, *H. W.* 1908.1, p. 175, not on fishes.

Breschet, *G.* & **Becquerel,** *A. C.* 1836.2, p. 180, not on fishes.

Brion, *C.* 1866.1, p. 183, correctly cited as Cicile-Brion, —, 1866.1, p. 236.

Browntree, *Walter S.* 1903.1, p. 190, correctly cited as Rowntree, W. S. 1903.1, vol. II, p. 367.

Burckhardt, *C. R.* 1893.1, p. 202, correctly cited as Burckhardt, C. R. 1894.2, p. 202.

Burgerstein, *A.* 1897.1, p. 203, not on fishes.

Cairncross, *D.* 1862.1, p. 208, not on fishes.

Campanyo, *L.* 1861.1, p. 211, correctly cited as Companyo, L. 1863.1, p. 258.

Carrigan, —, 1860.1, p. 219, correctly cited as Corrigan, D. J. 1860.1, p. 271.

Cerrigan, *D.* 1859.1, p. 226, correctly cited as Corrigan, D. J. 1863.1, p. 271.

Checcia-Rispoli, *G.* 1905.1, p. 230, not on fishes.

Clarke, *W. Branwhite,* 1838.1, p. 241, correctly cited as Clarke, William Barnard, 1838.1, p. 241.

Clark, *W. G.* 1898.1, p. 241, correctly cited as Clark, W. J. 1898.1, p. 241.

Cleef, *J. S. van,* 1885.1, p. 243, better cited as Van Cleef, J. S. 1886.1, vol. II, p. 577.

Clift, (*Rev.*) *William,* 1874.3, p. 244, correctly cited as Clift, M. 1874.1, p. 244.

Collett, *R.* 1876.1, p. 253, correctly cited as Collett, R. 1875.2, p. 253.

Cope, *E. D.* 1871.16, p. 261, correctly cited as 1870.6, p. 260; — 1882.1, p. 264, not on fishes; — 1892.4, p. 266, correctly cited as Eigenmann, C. H. & Eigenmann, R. S. 1892.3, p. 366.

Costa, *O. G.*, p. 272, 1840.1, correctly cited as 1829.1; — 1849.1, correctly cited as 1846.1; — 1855.1, correctly cited as 1857.1, which should have date of publication read 1855 (Memorie).

Coste, *P.* 1867.1, p. 274, correctly cited as Coste, J. J. 1867.1, p. 273.

Couch, *J.* 1849.1, p. 275, correctly cited as Couch, J. 1842.1, p. 275.

Couch, *R. Q.* 1844.1, p. 276, correctly cited as Couch, J. 1844.2, p. 275.

Crispo-Barbaro, *G.* 1877.1, p. 280, better cited as Barbaro, G. C[rispo]. 1869.1, p. 65.

Dahl, *K.* 1906.4, p. 290, correctly cited as Dahl, K. & Dannevig, G. 1906.1, p. 291.

Dahlgren, *U.* 1898.2, p. 291, delete citation from Journ. Morphol. 1898, vol. 14, 117–124.

Day, *F.* 1884.3, p. 306, same as Day, F. 1884.2, p. 306.

Dean, *B.* 1893.5, p. 308, citation was published in Trans. N. Y. Acad. Sci., vol. 12, pp. 70–71.

Dekay, *J. E.*, p. 314, should be written De Kay, J. E.

Delage, *M. Y.* 1887.1, p. 314, not on fishes.

Deslongchamps, *J. A. E.* 1831.1, p. 320, not on fishes.

Deynoot, *W. T. G.* 1829.1, p. 322, better cited as Gevers Deynoot, W. T. 1829.1, p. 454.

Dezsö, *Bela von,* p. 323, correctly cited as Desco, Bela von, p. 319.

Dixon, *B. I.* 1913.1, p. 325, should be written Dikson, B.

Dubois, *Emil.* This author and the following citations on p. 334 should be deleted. 1843.1, correctly cited under Du Bois-Reymond, E. H. Add. 1843.1, vol. III, p. 50; — 1843.2, correctly cited under Du Bois-Reymond, E. H. 1843.1, vol. I, p. 335.

Edwards, *H. M.* & **Coste,** —, 1850.1, p. 355, correctly cited as Milne-Edwards, A. & Coste, J. 1850.1, vol. II, p. 140.

Eigenmann, *C. H.* 1893.2, p. 362, same as 1892.3, p. 362; — 1893.3, p. 362, same as 1892.6, p. 362; — 1902.5, p. 363, same as 1903.3, p. 363; — 1904.1, p. 364, same as 1903.3, p. 363; — 1889.1, p. 361, correctly cited as

Eigenmann, *C. H.* Eigenmann, C. H. & Eigenmann, R. S. 1889.5, p. 366.

Ellis, *M. M.* 1907.1, p. 369, not on fishes.

Ewart, *J. C.* 1893.3, p. 384, same as Ewart, J. C. 1892.1, p. 384.

Fargioni Tozzetti, *A.* 1880.1, p. 390, correctly cited as Targioni-Tozzetti, A. 1880.1, vol. II, p. 530.

Favrau, *G. P.* 1909.1, p. 393, correctly cited as Farran, G. P. 1909.1, p. 390.

Forbes, *S. A.*, p. 406, 1903.1, included in 1880.1, p. 405; — 1903.2, included in 1800.3, p. 405.

Fortuyn, *A. B. Drooglever*, p. 409, these citations are properly included under Drooglever Fortuyn, A. B., p. 333.

Fourcroy, *A. F.* & **Vauquelin,** *L. N.* 1804.1, p. 409, not on fishes.

Franciscus, *Erasmus.* 1762.1, p. 414, correctly cited as Franciscus, Erasmus. Pre-Linn. 1668.1.

Fritsch, *A. J.* 1878.2, p. 422, same as Fritsch, G. T. 1878.1, p. 422.

Fritsch, *G. T.* 1886.2, p. 423, correctly cited as Fritsch, G. T. 1884.1, p. 423.

Fuchs, *H.* 1910.1, p. 425, not on fishes.

Fürbringer, *M.* 1875.1, p. 426, correctly cited as Fürbringer, P. 1875.1, p. 426.

Fuhrmann, *O.*, p. 427, 1905.3, same as 1905.6; — 1906.3, same as 1905.1.

Fullarton, *J. H.* 1895.1, p. 428, not on fishes.

Fulton, *T. W.* 1892.3, p. 429, same as 1891.5, p. 429; — 1904.3, p. 431, same as 1904.5, p. 431.

Gage, *S. H.* 1893.1, p. 435, correctly cited as Gage, S. P. Add. 1893.1.

Gambel, *W.* 1850.1, p. 436, not on fishes.

Gargiulo, *A.* 1903.1, p. 437, correctly cited as Cargiulo, A. 1904.1, p. 217.

Garnault, *P.* 1888.1, p. 439, not on fishes.

Gegenbaur, *C.* 1869.1, p. 444, same as Gegenbaur, C. 1870.3, p. 445.

Gent, *J. J.* 1873.1, p. 448, correctly cited as Josselyn, J. Pre-Linn. 1672.1.

Geoffroy-Saint-Hilaire, *E. F.* 1818.1, p. 450, correctly cited under this author as 1807.8, p. 449. For other corrections see this author in Addendum, vol. III, p. 70.

Geusch, *H.* 1882.1, p. 454, correctly cited as Gensch, H. 1881.1, p. 448.

Gilbert, *J. Z.* 1888.1, p. 461, not on fishes.

Gill, *T. N.*, p. 462, 1853.1, correctly cited as 1858.2; — 1853.2, correctly cited as 1858.3; — 1853.3, correctly cited as 1858.4; — 1853.4, correctly cited as 1858.5; — 1860.7, p. 463, contains no fishes.

Girard, *C. F.* 1853.1, p. 475, for correct citation see Baird, S. F. & Girard, C. 1853.2, p. 59; — 1853.2, p. 475, see Baird & Girard, 1853.3, p. 59; — 1854.1, p. 475, see Baird & Girard, 1853.1, p. 59; — 1854.2, p. 475, see Baird & Girard, 1854.1, p. 60; — 1854.3, p. 475, see Baird & Girard, Add. 1854.1.

Glaser, *O. C.* 1907.1, p. 478, not on fishes.

Glover, *T.* 1836.1, p. 479, correctly cited as Glover, T. Pre-Linn. 1676.1.

God, *Arthur.* 1902.1, p. 480, correctly cited as Good, Arthur. 1902.1, p. 484.

Goode, *G. B.* 1879.11, p. 486, correctly cited as Goode, G. B. & Bean, T. H. 1879.12, p. 490; — 1881.3, p. 487, same as 1880.10, p. 486.

Goode, *G. B.* & **Collins,** *J. W.* 1882.1, p. 491, same as Goode, G. B. & Collins, J. W. 1887.5, p. 491.

Gray, *G. R.* 1850.1, p. 499, correctly cited as Gray, J. E. 1850.1, p. 500.

Gray, *J. E.* 1825.1, p. 500, not on fishes.

Gregory, *W. K.* & **Adams,** *L. A.* 1914.1, p. 505. This article is by Gregory, W. K. alone.

Günther, *A. C.* 1880.3, p. 520, correctly cited as 1875.2, p. 519; — 1889.7, p. 521, same as 1889.3, p. 521.

Hall-Hüningen, (*Director*) 1894.1, p. 537, correctly cited as Haack, H. 1894.1, p. 532. Probably Director Haack of Hüningen.

Hamilton, *A.* 1902.2, p. 539, same as Hamilton, A. 1902.3, p. 539.

Hansen, *V.* 1883.1, p. 542, correctly cited as Hensen, V. A. 1883.1, p. 564.

Hardesty, *I.* 1908.1, p. 542, not on fishes.

Hay, *O. P.* 1899.4 and 1899.5, p. 554, not on fishes.

Helbing, *H.* 1902.1, p. 561, delete reference to Nova Acta Acad. Leopold. Correctly cited in 1904.1.

Herman, *L.* 1894.1, p. 569, not on fishes.

Heyke, *D.* 1744.1, p. 576, correctly cited as Heyke, D. Pre-Linn. 1744.2.

Hogg, *J.* 1858.1, p. 593, same as Hogg, J. 1854.1, p. 592.

Hohner, *G. M.* 1903.1, p. 593, correctly cited as Holmes, G. M. 1903.1, p. 597.

Holberg, *L.* 1819.1, p. 593, correctly cited as Hollberg, L. 1819.1, p. 596.

Hollard, *H. L.* 1864.2, p. 596, not on fishes.

Holmgren, *A. E.* 1894.1, p. 597, not on fishes.

Homburger, *R.* .1904.1, p. 601, correctly cited as Hamburger, R. 1904.1, p. 538.

Horsfield, *T.* 1821.1, p. 604, not on fishes.

Houssay, *F.* 1901.1, p. 605, not on fishes.

Imbert, *A.* 1909.1, p. 619, properly cited under Borcéa, J. 1909.3, p. 152.

Inge, *M.* 1899.1, p. 619, correctly cited as Juge, M. 1899.1, p. 664.

Jaekel, *O. M.* 1898.3, p. 626, correctly cited as Jaekel, O. M. 1898.1, p. 625.

Jardine, (*Sir*) *W.*, p. 630, — "Fishes of Guiana," correctly credited to Schomburgk, R. H. 1841.1, p. 417.

Johnstone, *J.* 1905.1, p. 639, included in 1904.1; — 1912.1, p. 640, included in 1909.2.

Jordan, *D. S.* 1878.12, p. 644, same as 1877.1 (iiiB), p. 644; — 1909.1, p. 650, correctly cited as Jordan, D. S. & Evermann, B. W. 1909.1, p. 652.

Kaup, *J. J.* 1834.1, p. 672, correctly entered under S. —, Add. 1834.1, p. 166.

Keferstein, *W. M.* & **Kupffer,** *C.* 1857.1 and 1858.1, p. 674, correctly cited under Kupffer, C. & Keferstein, W. 1857.1, and 1858.1, p. 716.

Kendall, *W. C.* & **Radcliffe,** *L.* 1912.1, p. 677, should read vol. 35, not 25.

Klein, *E. E.*, pp. 687 and 688, all citations, save 1872.1 and 1876.1, should be credited to Klein, A. von; 1884.1 is already so credited.

Kölliker, *R. A.* 1859.1 and 1859.2, p. 700, correctly cited under Kölliker, R. A. 1857.3, p. 699.

Kreyenberg, *M.*, p. 710, 1911.3, same as 1911.1; — 1910.1, correctly cited as Kreyenberg, M. & Pappenheim, P. 1908.1.

Krukenberg, *C. F.* 1887.1, p. 712, contains no fishes.

La Blanchère, *P. R.* 1878.1, p. 2, correctly cited as La Blanchère, P. R. 1876.2, p. 2.

La Chapelle, — *de*, 1820.1, p. 3, correctly cited as Chapelle, — de la, Pre-Linn. 1733.1.

Lahille, *F.* 1913.3, p. 6, should read " Arica " not " Africa."

Le Boux, *M.* 1887.1, p. 20, correctly cited as Le Roux, M. 1887.1, p. 35.

Leiper, *R. T.* 1908.1, p. 27, not on fishes.

Leuckart, *C. G.* 1860.1, p. 38, not on fishes.

Leydig, *F.* 1909.1, p. 42, should read 1902.1.

Link, *H. F.* 1790.1, p. 46, correctly cited as Linck, H. F. Add. 1789.1.

Loewe, *Fr.* 1896.1, p. 59, year of publication should be 1904 and reference number 1904.1.

Lowe, *R. T.* 1840.3, p. 64, included in 1840.1; — 1854.1, p. 65, correctly cited under Brandt, J. F. & Lowe, R. T. 1854.1, p. 176, vol. I.

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Lyngbye, *H. C.* 1826.1, p. 75, not on fishes.

MacCallum, *G. A.* 1913.1, p. 77, correctly cited as MacCallum, G. A. & MacCallum, W. G. Add. 1913.1.

M'Clelland, *J.* 1842.2, p. 78, included in M'Clelland, J. 1842.3.

MacCulloch, *J.* 1824.2, p. 80, same as MacCulloch, J. 1823.1.

McGovern, *H. D.*, p. 83, 1879.1, not on fishes.

Macks, *J. A.*, p. 89, should be written Op de Macks, J. A.

Maitland, *J. R. Gibson*, vol. II, p. 94, better cited as Gibson-Maitland, J. R. vol. I, p. 457.

Mangoldt, *E.*, p. 98, should be written Mangold, E.

Marsh, *M. C.* & **Gorham,** *F. P.* 1906.1, p. 105, should be Marsh, M. C. (Sole author).

Mayer, *A. F.* 1862.2, p. 119, correctly cited as Mayer, A. F. 1862.1.

Meyer, —, 1872.1, p. 132, correctly cited as Meyer, R. 1872.1, p. 135.

Möbius, *K. A.* 1871.2, p. 146, not on fishes.

Modoerin, *A.* 1885.1, p. 146, better cited under Madörin, A. 1885.1, p. 91.

Mondini, *C.* 1783.1, p. 150, correctly cited as Mundini, C. Add. 1783.1.

Montgomery-Vignal, *M. W.*, p. 151, is more correctly written Vignal, W. V. M(ontgomery), p. 584.

Morton, *Allport.* 1878.1, p. 158, correctly cited as Allport, M. 1878.1, vol. I, p. 23; — 1893.1–1897.1, p. 158, should read Morton, Alexander.

Moulder, *E.* 1861.1, p. 160, correctly cited as Mulder, E. 1861.1, p. 167.

Müller, *J.* 1835.1, p. 163, correctly cited as Eschricht, D. F. & Müller, J. 1835.2, vol. I, p. 375.

Müller, *J.* & **Eschricht,** *D. F.* 1835.1, p. 165, correctly cited as Eschricht, D. F. & Müller, J. 1835.1, vol. I, p. 375.

Müller, *W.* 1897.1, p. 166, correctly cited under Müller, F. W. 1897.1, p. 162.

Nardo, *G. D.* 1844.3, p. 173, date under second reference should be changed to 1853. See Nardo, G. D. 1853.1.

Newbold, *T. J.* 1849.1, p. 181, correctly cited as Newman, Edward. Add. 1849.1.

Nikolskiĭ, *A. M.*, p. 180, 1900.3, included in 1899.1; — 1902.2, same as 1902.1; — 1903.1, same as 1903.3; — 1904.1, same as 1903.2.

Nordqvist, *O. F.*, p. 195, 1892.8, 1894.8, 1894.10, not on fishes;—citations 1908.2, 1911.1, 1912.1, 1913.1, 1914.1, p. 198, under this author, should properly be credited to Nordqvist, Harald.

Norny, *E. R.* 1885.1, p. 199, correctly cited as Norny, E. R. Add. 1885.1.

Ogilby, *J. D.* 1885.5, p. 207, same as Ogilby, J. D. 1885.6.

Oshima, *K.* 1911.1, p. 217, correctly cited as Ohshima, K. 1911.1, p. 209.

Otto, H. 1908.1, p. 219, not on fishes.

Paton, *D. N.* & others. 1898.1, p. 236, correctly cited as Paton, D. N. 1898.1, p. 236.

Pellegrin, *J.* 1904.2, p. 244, year of publication in citation should read 1903; — 1907.9, p. 245, and 1909.8, p. 246, correctly cited as 1908.6, p. 246; — 1910.1, p. 247, should read 1909; — 1911.5, p. 247, included in 1912.5, p. 248.

Peltzam, *E. D.* p. 249, should be written Pel'tzam, E. D.

Perengia, *A.* 1879.1, p. 250, correctly cited as Perugia, A. 1880.1, p. 253.

Petersen, *C. G. J.* 1902.1, p. 257, included in Petersen, C. G. J. 1902.4.

Peyrl, *Theodor.* 1910.1, p. 260, probably same author as Peyerl, Theodor. 1916.1, p. 260.

Pietschmann, *V.* 1907.1, p. 267, should have the following part of the title deleted, "Zwei stark variante Exemplare von Antennarius, etc." This is properly recorded under Pietschmann, V. 1909.2, p. 268; — 1908.2, p. 267, should be deleted. Same as 1907.1.

Platner, *G.* 1888.1, p. 271, contains no fishes.

Preyer, *C.* 1876.1, p. 285, correctly cited as Peyrer, C. 1876.1, p. 260.

Priem, *F.* 1907.4, p. 287, same as Priem, F. 1907.2, p. 286.

Priesbergen, *F.* 1886.1, p. 287, correctly cited as Piesbergen, F. 1886.1, p. 267.

Putnam, *F. W.*, p. 292, 1865.3, correctly cited under 1865.5; — 1865.6, correctly cited under 1866.1; — 1865.7, correctly cited under 1865.1; — 1866.6, correctly cited under Add. 1865.1; — 1870.6, correctly cited under 1870.3.

Pylaie, — *de la,* 1834.1, p. 294 better cited as De la Pylaie, —, 1835.1, p. 315, vol. I.

Regan, *C. T.* 1909.12, p. 322, same as Regan, C. T. 1909.9, p. 322.

Reguart, *A. S.* 1791.1, p. 326, better cited as Sañez Reguart, A. 1791.1, p. 385.

Riviére, *E.* 1887.1, p. 351, correct year of publication is 1886.

Robin, *A.* 1883.1, p. 352, correctly cited as Robin, C. P. 1883.1, p. 352.

Rockwell, *A. P.* 1876.1, p. 354, correctly cited as Rockwood, A. P. 1876.1, p. 354.

Röse, *C.* 1889.1, p. 355, year of publication should be 1890; — 1890.1, p. 355, same as Röse, C. 1889.1.

Rose, *V.* 1805.1, p. 361, not on fishes.

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Ryder, *J. A.*, p. 373, 1886.4, correctly cited as 1886.8; — 1886.5, same as 1885.6.

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Sanctis, *Leone de,* 1881.1, p. 382, not on fishes.

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Williamson, *H. C.* 1850.1, p. 632, correctly cited as Williamson, W. C. 1851.1, p. 634.

Williston, *S. W.* 1894.1, p. 634, not on fishes.

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No. 78, p. 679. See Rooper, G. 1867.1, p. 359, vol. II.

No. 104, p. 681. See Goode, G. B. 1871.1, p. 484, vol. I.

No. 153, p. 683. See Denison, (Sir) W. 1862.1, p. 318, vol. I.

No. 158, p. 683. See Owen, R. 1854.1, p. 222, vol. II.

No. 159, p. 683. See O., 1832.1, p. 206, vol. II.

No. 163, p. 683. See Duhamel du Monceau, H. 1796.1, p. 338, vol. I.

No. 202, p. 684. See Bocage, J. V. 1878.1, p. 141, vol. I.

No. 267, p. 686. See Evermann, B. W. 1904.3, p. 380, vol. I.

No. 292, p. 688. See Reste, B. de 1801.1, p. 336, vol. II.

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No. 569, p. 699. See Zur Mühlen, M. von. 1911.18, p. 676, vol. II.

No. 596, p. 700. See Volpi, — 1796.1, p. 590, vol. II.

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Gilson, *G.* Add. 1908.1, p. 75, better cited under Gilson, G. 1908.1, vol. I, p. 474.

VIII

SUBJECT INDEX

MORPHOLOGICAL AND GENERAL SECTION [1]

ABDOMINAL PORES (*OF FISHES*)

Or Pori abdominales, including a discussion of the "genital pores" (Pori genitales) with which they have been frequently confused.

The abdominal pores

"Abdominal pores [as defined by Bles, E. J. 1898.1, p. 484] are the external apertures, usually paired, found in many Anamnia and some Amniota in the cloacal region, affording a passage of communication from the abdominal cavity to the exterior. The integument surrounding the pores externally is invariably ectodermic in origin, usually proctodæal. Internally the pores lead into the body cavity, or into passages — the peritoneal canals — communicating with the body-cavity."

They occur in numerous genera in the Cyclostomes, Elasmobranchs, Dipnoi, and Teleostomes, except in the Teleostei, where only two families possess them. They are subject to considerable variation in position and are often absent in individuals of species in which they normally occur. In other individuals they may be open on one side and closed on the other. In some species they open into the cloaca and in others, directly to the exterior. These minute openings are often difficult to demonstrate but, when present, they may generally be disclosed by injecting the body-cavity with mercury.

The abdominal pores are considered to be "excretory ducts" by Bles (E. J. 1898.2, p. 243) who has made the interesting observation that in those sharks in which open peritoneal funnels persist and function throughout life, the abdominal pores are generally absent. (For a further discussion of this subject, *see below* "Urogenital system of Elasmobranchii" *under* "Urogenital system.")

Gegenbaur (C. 1870.1) believed that, in the primitive vertebrates, the abdominal pores were probably the sole efferent channels for the sexual products. In contrast with this view, Bles (E. J. 1898.1, p. 505) believes that the abdominal pores "never serve under normal circumstances as genital ducts," this function being performed by the true gonoducts or where these have degenerated, as will be made clear later, by the "genital pores."

In the Teleostei, true abdominal pores occur only in certain genera (*Argentina*, *Coregonus*, and *Salmo*) of the Salmonidæ (used in the older sense), and, as was first pointed out by Hyrtl (C. J. 1856.1, Add. 1849.1), in various species of *Mormyrus* and in *Gymnarchus niloticus* of the Mormyridæ. The abdominal pores exist in both sexes.

The most illuminative and complete papers (in English), on the abdominal and genital pores, are those of ★Bles, E. J. **1898.1**, 1898.2.

The most recent summary in German is that of ★Lickteig, A. 1913.1.

The subject of abdominal and genital pores in the Teleostei, is best treated by ★Weber, M. C. 1886.1.

The confusion, among the older writers, of abdominal and genital pores, especially of Balfour (F. M. 1876.2, p. 35), *which was repeated by his pupil,* Bridge (T. W. 1879.1), *was first cleared by the remark of* Huxley (T. H. 1883.2, p. 137) *that the so-called abdominal pore of salmonoids "has nothing to do with the abdominal pores of . . .* [Ganoids and] Selachians." *This view was accepted by* Gegenbaur (C. 1885.1). *The confusion was finally cleared by the careful elucidation of* ★Weber (M. C. 1886.1).

The genital pores

When the generative ducts (oviducts) disappear, their external openings persist as the *genital pores.* Through these openings the sexual products are extruded. Except possibly in the Cyclostomata, true "genital pores" exist, as far as known, only in two families of Teleosts, namely the Salmonidæ and the Anguillidæ. As long ago pointed out by Rathke (M. H. 1820.2), the oviduct in the eel has entirely disappeared. Various stages in the degeneration of the oviducts are found in the Galaxiidæ, Hyodontidæ, Notopteridæ, Osteoglossidæ, and in Misgurnus, as has been shown by Hyrtl (C. J. 1850.1, 1851.2) and by MacLeod (J. 1881.3). In the Salmonidæ, the oviduct has practically disappeared.

Abdominal pores and genital pores co-exist in but one family of Teleosts, namely in the female Salmonoid.

In the Mormyridæ, the only other family of Teleosts possessing abdominal pores, the oviducts have not degenerated so that genital pores are not present.

Pores of the Cyclostomata

In this group, the genital products (eggs and sperms) are discharged through a median pore or a pair of pores.

The exact morphological nature of these pores, *i. e.*, whether abdominal or genital pores, remains in obscurity. Bles (E. J. 1898.2, p. 238) says that there is "great probability that the so-called abdominal pores of Cyclostomes are genital ducts, morphologically as well as functionally." Lickteig (p. 282), however, considers them to be true abdominal pores, and believes that it is only in this group that the abdominal pores serve as channels for the sexual products. From *à priori* considerations, this view is probably correct.

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[1] Arranged under the 118 specific and technical headings herewith given.

For fossil forms, natural history, occurrence, taxonomy, etc., matters relating to specific fishes or groups of fishes, *see in the* Systematic Section.

Abdominal Pores — *Cont'd.*

In the lamprey (Petromyzon), in which the eggs are small, there is a pair of small pores opening into an urogenital sinus. Ewart, J. C. 1876.1.

In the Myxinoids, which have large eggs, Myxine possesses a single, median pore, of very considerable size, opening into a cloacal chamber, while Bdellostoma has an enormous pore divided into two. ★Burne, R. H. 1898.1.

Abdominal pores of Elasmobranchii

Abdominal pores are usually present in this group, but are subject to considerable variation, being often present on one side while absent on the other. The Cestraciontidæ and Rhinidæ lack them entirely. In other forms (*Scyllium stellare, S. canicula, Pristiurus melanostomus, Spinax niger*), they appear only at sexual maturity and may in certain individuals be absent.

A table showing their distribution appears in ★Bles, E. J. 1898.2.

Other papers of lesser importance relating to the abdominal pores of sharks are Bridge, T. W. 1879.1; Howes, G. B. 1890.3; Schneider, G. 1897.1; *and* Turner, W. 1879.1.

Abdominal pores in Teleostomi

The distribution of abdominal pores in this group, together with the literature, is fully given by Bles (E. J. 1898.1).

The Crossopterygii possess them as demonstrated in *Polypterus* by Hyrtl, and in *Calamoichthys* by Bridge.

The Chondrostei: *Polyodon* has abdominal pores (A. Wagner, and Hyrtl); while practically all species of *Acipenser* have them (Johannes Müller, Hyrtl, and Stannius).

The Holostei: " *Amia calva* — This fish was carefully examined by Hyrtl, and at first without success, for the presence of abdominal pores. He discovered them in a large specimen as very fine canals . . . Bridge confirms Hyrtl's observations, adding that the pores are open in both sexes."

"*Lepidosteus osseus* finally, like all other known Ganoids, has abdominal pores. They were described and figured by Hyrtl and mentioned by Bridge, but were first discovered by Joh. Müller." (Bles, E. J. 1898.1, p. 502.)

Various papers on the abdominal pores of the Teleostomes, are Ayers, H. 1884.1; Hyrtl, C. J. 1852.1, 1854.2; *and* Ionescu, C. N. 1905.1.

Abdominal pores of Dipnoi

" According to Hyrtl, *Lepidosiren paradoxa*, Fitz., has no peritoneal canals or abdominal pores; and Bischoff [T. L. 1840.1] . . . makes no mention of such openings. Ceratodus, on the other hand is well known to have pores, as first described by Günther [A. C. 1871.4], paired and opening behind the cloaca.

" . . . P[rotopterus] annectens . . . has abdominal pores." Bles, E. J. 1898.1, p. 504.

ADAPTATIONS

See also Ecology, Evolution, etc.

For adaptations to varying saline content of water; adaptations of freshwater fishes to sea-water and vice versa, *see under* Physiology.

For adaptation of coloration to surroundings, *see under* Coloration; in form or shape of fishes, *see under* Form.

For adaptations to their peculiar habitat and manner of life, *see* Blind Fishes of the Caves, Deep Sea Fishes, and Pelagic Fishes.

Generalia. Agassiz, J. L. 1854.4; Baird, S. F. 1871.47; ★Eigenmann, C. H. 1909.1 (*Address*); Fatio, V. 1904.1, 1905.1; Nichols, J. T. 1915.1,.7; Osburn, R. C. 1911.11; Prince, E. E. 1901.1.

Adaptations to an aquatic habitat. Abel, O. 1905.1. — *To terrestrial existence.* Cuénot, L. 1895.1. — *Deep-sea fishes.* Delaroche, F. E. 1809.3.— *Adaptations of sailfishes to a pelagic life.* Dollo, L. 1909.5. — *Adaptations illustrating " habitus " and " heritage."* Gregory, W. K. & Adams, L. A. 1914.1. — *Sagittiform structure of nectonic fishes.* Schlesinger, G. 1909.1.

Adaptations of Scomberesocidæ to a pelagic manner of life. Schlesinger, G. 1909.2. — *Adaptations of Mormyridæ to manner of food gathering.* Schlesinger, G. 1910.2,.4. — *Adaptation of Gobiidæ to a planktonic life.* Brunelli, G. & Atella, E. Add. 19141.

Adaptations of fossil fishes to their manner of life. ★Dollo, L. 1909.4; Abel, O. Add. 1914.1.

ADHESIVE DISK

General treatise on the adhesive disk of fishes. ★Niemiec, J. 1885.1.

Fixation against the current by means of spines acting as adhesive organs. Thilo, O. 1900.1,.2, 1903.1.

Disk formed through a modification of the dorsal fin. — *In Echeneis.* Beck, G. 1879.1; Cope, E. D. 1889.4; Home, E. 1816.1; ★Houy, R. **1909.1**; Storms, R. 1888.1; Townsend, C. H. 1915.1. — *Fossil showing disk.* Wettstein, A. 1886.1.

In Remora. Baudelot, E. 1867.3; Blainville, H. M. 1822.2; Kner, R. 1860.2.

Disk formed by the united ventral fins. In — *Cyclopterus.* Baudelot, E. 1868.7; Borckert, H. 1889.1; ★Guitel, F. 1891.3, 1896.1. — *Liparis.* Reicher, E. 1913.1; Stuckens, M. 1884.1; Smith, W. A. Add. 1885.1.—*Lepadogaster.* Fiebiger, J. 1905.1; Smith, W. A. Add. 1885.1.

ADHESIVE OR CEMENT ORGANS

Transient larval organs, situated as a crescent-shaped median furrow or a pair of knobs near the mouth, being glandular and serving to aid in the attachment or cementing to surroundings of the larval fishes.

In Amia, as first pointed out by Reighard and Phelps (1908.1), these are of endodermal origin arising in the form of pockets which later, however, separate and fuse with the ectoderm. By them, they were homologized with the anterior pair of head cavities of Elasmobranchs. Kerr (J. G. 1906.1) has suggested their possible correspondence with the premandibular head cavities of higher vertebrates.

In Dipnoi (Protopterus and Lepidosiren), and Amphibia, the cement organs are apparently of ectodermal origin, but Professor Kerr believes that here the endodermal stages have been eliminated from the embryonic development.

Structure and development in — Protopterus, Hyperopisus, and Sarcodaces.

Budgett, J. S. 1900.5. — *Amia*. ★Eycleshymer, A. C. & Wilson, J. M. 1908.1; Phelps, J. 1900.1; Reighard, J. E. 1900.2; Reighard, J. E. & Phelps, J. 1908.1. — *Lepidosiren and Protopterus*. Kerr, J. G. 1900.1 (iii). — *Polypterus*. Kerr, J. G. 1907.2. — *Acipenser*. Kupffer, C. 1893.1; ★Sawadsky, A. M. 1911.1,.2.

ÆSTIVATION

The manner in which fishes survive drying of water courses by embedding in mud, etc.

Miscellaneous. Huard, V. A. 1903.1; Milewski, A. 1915.9. — *Earliest known account of this phenomenon*. Theophrastus. Pre-Linn. 1495.1.

Æstivation of various fishes. — *Embedding of carp, perch, etc., in mud at disappearance of the stream and their reappearance after rainfall*. Buchanan, J. Y. 1911.1. — *Indian fishes*. ★Day, F. 1877.3. — *Lepidosiren*. Kerr, J. G. 1898.2, 1900.1. — *Galaxias*. Hall, T. S. 1901.1; Fletcher, – Add. 1906.1; Stead, D. G. Add. 1907.6, .7. — *Australian fishes*. Spencer, B. Add. 1896.1.

Æstivation of the African lungfish, Protopterus; structure, chemical composition, etc., of the cocoon, resumption of active life after the torpid condition, etc. Allen, G. 1885.1; Dean, B. 1912.5; Dubois, R. 1892.1; Geoffroy-Saint-Hilaire, A. 1863.1; Jardine, W. 1841.1; Macdonnell, R. 1860.1; Meyer, R. 1866.1; Parker, W. N. 1888.2, 1889.2, 1892.1; Sarasin, F. 1905.1; Walther, G. 1889.1; Wiedersheim, R. E. 1887.3.

For the manner in which fishes pass the winter season, see Hibernation.

For Burrowing Habits *of various nonæstivating fishes, see this subject under* Habits of Fishes.

AIR BLADDER

General accounts of the anatomy, physiology, etc. ★Bridge, T. W. 1890.2, 1904.1; ★Bridge, T. W. & Haddon, A. C. 1889.1, **1893.1**; Day, F. 1880.1,.8; Döllinger, I. 1804.1; Hasse, J. C. 1873.1; Lloyd, J. 1869.1; Morris, C. 1886.1; Reis, K. 1907.1; Reissner, E. 1859.2.

Miscellaneous papers on the air bladder. Bist, – 1807.1; Günther, A. C. 1874.2; Hancock, J. 1830.1; Houghton, W. 1868.2; Huber, R. O. 1908.1; Janson, O. 1905.1; Leonhardt, E. E. 1905.2; Prudhomme, – 1811.1; Sussdorf, J. 1862.1; Vion, R. 1881.2; Anon, 439, 532, 566; Foley, A. Add. 1863.1. — *Pre-Linn. refs.* Hanow, M. 1737.1; Ray, J. 1675.1.

Development of air bladder. *General discussions*. Agassiz, J. L. 1850.8; Baer, K. E. 1834.1, 1836.1,.2,.3; ★Moser, F. **1903.1**; Stricker, F. 1899.1; Thilo, O. 1904.1; ★Goeppert, E. Add. **1902.1**.

Development of air bladder in — Clupea. Nedozhivin, A. J. 1912.1. — *Tetrodontidæ, and carp*. Thilo, O. 1899.1, 1908.3, 1914.1. — *Lophobranchii*. Weber, A. 1886.2,.3.

Homologies with lungs. *Consideration of the genetical relations existing between the air bladder of fishes and the lungs of higher vertebrates. Conclusions based chiefly upon the study of the Dipnoi.*

Considered homologous. Greil, A. 1905.1; Kerr, J. G. 1908.1; Morris, C. 1892.1; Goette, A. 1904.1; Müller, F. W. 1911.1; ★Spengel, J. W. **1904.1**; Wiedersheim, R. E. 1904.2; Makuschok, M. Add. 1913.1; Oppel, A. Add. 1905.1.

Considered not homologous. Albrecht, P. 1886.1; Müller, J. 1841.4.

For the structure of the air bladder in individual Dipnoi, see below under Specialized air bladders.

Anatomy and morphology

For the connections with the membranous labyrinth by tubular prolongations, and by the Weberian apparatus, see under Auditory organs.

Larger, and more important papers on the anatomy and morphology of the air bladder. Deinek, D. I. 1901.1, 1904.1; Jacobi, H. S. 1840.1; Jacobs, C. 1898.1; ★Jaeger, A. **1903.1**; Müller, J. 1842.2; ★Reis, K. **1907.1**; Tracy, H. C. 1910.2, 1911.1; Oppel, A. Add. 1906.2.

Various smaller papers. Baudelot, E. 1873.1; Berlack, J. 1834.1; Cuénot, L. 1887.1; Cuvier, G. L. 1809.1; Delaroche, F. E. 1809.2; Faivre, E. 1854.1; Huschke, E. 1818.1; Kner, R. 1864.3; Rathke, M. H. 1827.1.

Earliest general account. Fischer von Waldheim, G. 1795.1. — *Considered a degenerate gland*. Prince, E. E. 1906.1. — *Ossified in certain fishes*. Thilo, O. 1913.1.

Ducts *for the communication of the air bladder with the exterior.*

Ductus pneumaticus, connection between air bladder and alimentary canal, of Physostomi. ★Rowntree, W. S. 1903.1.

Posterior communication with cloaca in herring. Bennett, F. W. 1879.1; Starks, E. C. 1911.1. — *No cloacal communication in Ophiocephalus*. Starks, E. C. 1911.2.

Duct ending in right branchial cavity of Caranx. Moreau, F. A. 1875.1,.6, 1876.1,.4.

Retia mirabilia. *Called also red glands, gas glands, ovals, etc.*

For an old but excellent account of Retia mirabilia in teleostean fishes, see Müller, J. 1840.4.

Morphology, histology, functions, etc. Coggi, A. 1886.1, 1889.1; Corning, H. K. 1888.1; Nusbaum, J. 1907.2; Nusbaum, J. & Bykowski, L. (*Fierasfer*) 1904.1, 1905.1; Nusbaum, J. & Reis, K. 1905.1; Quekett, J. T. 1842.1; ★Reis, K. 1906.1, .2; Reis, K. & Nusbaum, J. 1905.1, 1906.1; Robin, C. P. 1883.1; Seabra, A. F. 1897.1; Vincent, S. & Barnes, A. S. 1896.1; ★Woodland, W. N. 1908.1, 1911.1,.2, **1911.3**, 1913.1.

Rudimentary, and degenerate air bladders. — *In Selachii*. Mayer, P. 1894.2; Miklukho-Maklai, N. N. 1867.1. — *In young of Comephorus baicalensis.*

Air Bladder — *Cont'd.*

Reis, K. 1909.1. — *Degeneration in Pleuronectidæ.* Thilo, O. 1907.3.

Specialized air bladders, *including the so-called "lung" of Dipnoi or Lungfishes.*

For the use of these organs in breathing, see Aerial respiration *under* Respiration.

Anatomy and development of lung in the lungfish, Neoceratodus. Günther, A. 1871.4; Neumayer, L. 1904.1; Wilson, G. 1901.2. — *Neoceratodus and Protopterus.* Spencer, W. B. 1898.1.

Anatomy in Lepidosteus. Hoeven, J. 1841.1; Hyrtl, C. J. 1852.2; Packard, A. S. 1859.1; Poey y Aloy, F. 1858.1; Valentin, G. G. 1840.1.

Anatomy in Polypterus. Harrington, N. R. 1899.2; Wiedersheim, R. E. 1906.1.

Larynx: occurrence, anatomy, musculature, etc., in Dipnoi and Ganoidei. ★Wiedersheim, R. **1904.2,** 1904.1,.3.

Anatomy and morphology of the air-bladder of various Teleosts

Physoclisti, *fishes lacking an open ductus pneumaticus from the air-bladder to the oesophagus.* — *Dactylopterus.* Calderwood, W. L. 1890.1. — *Sciænidæ.* Cohn, L. 1907.1; Cuvier, G. L. 1815.1. — *Uranoscopus.* Costa, O. G. 1846.4. — *Caranx.* Hyrtl, C. J. 1849.3. — *Macropodus.* Marcinkiewicz, M. 1911.1. — *Ophidium,* Putnam, F. W. 1874.4. — *Oligopus (Gadopsis).* Filippi, F. Add. 1855.1. — *Plectognaths.* Rosén, N. 1912.1, Add. 1912.1.

Physostomi, *fishes having an open ductus pneumaticus communicating with the oesophagus.* — *Malacopterygii.* ★Beaufort, L. F. **1909.1.**

Air bladder of certain Cyprinidæ. — *Nemachilus.* Bloch, L. 1900.1. — *Cobitidæ.* Grobben, C. 1875.1; Jaquet, M. 1894.2. — *Cyprinidæ.* ★Guyénot, E. 1906.1; Leonhardt, E. E. 1903.11.

Structure of air bladder in various Siluridæ. Bridge, T. W. 1890.1. — *Doras.* Kner, R. 1854.3. — *Amiurus.* Macallum, A. B. 1884.1. — *Siluroides nebulosus.* Reis, K. 1905.1.

Air bladder of Notopterus. Bridge, T. W. 1900.1. — *Esox.* Czermák, J. N. 1850.1. — *Coregonus and Anguilla.* Haempel, O. 1909.1. — *Erythrinus.* Jacobi, H. S. 1840.1. — *Carapus.* Kaup, J. J. 1856.5. — *Apodes.* Kner, R. 1866.6. — *Anguilla.* Pauly, A. 1882.1. — *Gymnotini.* Reinhardt, J. T. 1852.1 — *Pœciliidæ.* Langer, W. F. 1913.1. — *Clupeidæ.* Regan, C. T. 1911.1; Ridewood, W. G. 1891.1.

Nature of gaseous content

The gases of the air bladder consist of oxygen and nitrogen with small quantities of carbon dioxide.

Various papers, researches, notes, etc. Biot, J. B. 1807.1, Add. 1807.1; ★Bohr, C. 1892.1; Erman, P. 1808.1; Fourcroy, A. F. 1789.1; ★Huefner, C. G. 1892.1; ★Moreau, F. A. 1862.2, 1863.3,.4, 1864.3–1879.1; Richard, J. 1895.1, 1896.2; Schlœsing, T. & Richard, J. 1896.1 *(Argon)*; Schultze, F. 1872.1; Tower, R. W. 1902.2; Traube-Mengarini, M. 1887.1, 1889.1, Add. 1888.1; Brodbelt, F. R. Add. 1796.1, 1797.1; Configliacci, P. Add. 1809.1, 1811.1; Krukenberg, C. F. Add. 1881.1.

Variation at different depths (almost pure oxygen at greater depths). Moreau, F. A. 1874.1,.2, 1875.4; Wittmack, M. C. 1876.1.

Physiology and functions

For the air bladder as a respiratory organ, see Aerial respiration *under* Respiration.

For the action of the extrinsic muscles of the air bladder in producing sounds, see under Sound production.

General treatises on the physiology of the air bladder. ★Baglioni, S. **1908.3;** Bjeletskij, N. F. 1883.1; ★Popta, C. M. 1910.1, 1912.1; Kuiper, K. Add. 1914.1.

Other important accounts. ★Guyénot, E. 1909.1, 1912.1; Jaeger, A. 1903.1–1906.1; Liebreich, O. 1890.1,.2; Marangoni, C. 1879.1, 1880.1; Treviranus, G. R. 1812.1, 1817.1; Wegener, M. 1910.2; Priefer, B. Add. 1892.1.

Shorter and non-technical accounts. Day, F. 1880.3; Erxleben, J. C. 1798.1; Geoffroy-Saint-Hilaire, E. 1809.3; Gorka, S. 1908.1; Gouriet, E. 1866.1;✓ Meigen, – 1856.1; Quekett, J. T. 1842.1; Reis, K. & Nusbaum, J. 1907.1; Sprenger, W. 1900.4; Waldschmidt, J. 1906.1; Lendenfeld, R. Add. 1897.1.

Experimental researches: effects on gas production of transection of the vagus and sympathetic nerves. Bohr, C. 1894.1; Harting, P. 1865.1; Moreau, F. A. 1865.1. — *Results of excision.* Giaja, J. 1908.1. — *Use of physometer.* Harting, P. 1872.2, 1874.2.

Belief that air bladder is filled only through ductus pneumaticus. Thilo, O. 1914.1.

Earliest scientific work on functions of air bladder. Borelli, G. A. Pre-Linn. 1680.1; J. A., 1675.1.

Hydrostatic functions, *or the methods by which fishes rise and sink.* Bonnier, P. 1895.1; ★Charbonnel-Salle, L. **1887.1;** Corblin, H. 1887.1; Dei, A. 1895.1; ★Moreau, F. A. 1875.3,.5,.6, 1876.5, 1879.1; Regnard, P. 1895.2; Hesse, R. Add. 1913.1; Musy, M. Add. 1912.1.

Density of fishes: fresh-water fishes weigh slightly less, most marine forms slightly more, and Pleuronectidæ relatively much more, than the amount of water displaced. Magnan, A. & La Riboisière, J. 1912.2.

ALIMENTARY CANAL OF FISHES

Comprising the morphology of the digestive tract in fishes.

For the functions of the alimentary canal, *see* Digestion.

For other organs derived from or associated with the alimentary tract, *see* Air bladder, Liver, Pancreas, Spleen, etc.

For an exhaustive treatise on the histological structure of the alimentary canal with a full bibliography, consult ★Oppel, A.

(1896.1), "Lehrbuch der vergl. Mikro. Anat.," 1896, pt. 1, (*Magen*) pp. 28 88; pt. 2, (*Schlund u. Darm*) 32 54; 160–170. *For references to* pt. 3, *see* Oppel, A. Add. 1900.1.

For a readable summary, see the chapter in ★Bridge, T. W. 1904.1.

ORAL CAVITY, PHARYNX, AND ŒSOPHAGUS

For general discussions of the development of these parts, see ★Goeppert, E. Add. **1902.1**; *and* ★Oppel, A. Add. **1900.1.**

For various pharyngeal derivatives, see Post-branchial body, Thymus Gland, Thyroid Gland, *etc.*

Phylogeny of the mouth, "the old mouth and the new," etc., chiefly discussions of Dohrn's theory of the origin of the present mouth of vertebrates through the coalescence of a pair of gill-clefts. Beard, J. 1888.4; Dohrn, F. A. 1882.2 (i); Fürbringer, M. 1900.1; Gaskell, W. H. 1898.1 (vi); Jaekel, O. 1906.4, 1907.1; Ayres, H. Add. 1907.1.

Embryological development of the oral or buccal cavity or mouth in — Amphioxus. Legros, R. 1898.1. — *Cyclostomata.* Peter, K. 1906.1. — *Bdellostoma.* Stockard, C. R. 1906.2. — *Acipenser.* Zavadskii, A. M. 1912.1.

Structure of the protrusible, spout-like mouth parts of Acipenser. Jourdain, S. & Friant, A. 1877.1.

Structure of the lips of Capoeta and Schizothorax. Pavlovskii, E. 1910.1, 1911.1.

Hypobranchial groove of Tunicates, Amphioxus, and Cyclostomes. Müller, W. 1873.1.

For cases of Buccal occlusion or absence of mouth, see Abnormalities of skull *under* Teratology.

Anatomy of — Œsophagus in selachii. Kreuter, E. 1903.1. — *Pharynx in Ganoids and Dipnoi.* Wiedersheim, R. E. 1904.2,.3. — *Œsophageal papillæ.* Gerhardt, U. Add. 1914.1.

Histology of the lining epithelium (generally squamous) of the buccal cavity or œsophagus in — Unclassified. Bornaud, E. 1887.1. — *Torpedo.* Drzewina, A. 1909.1, 1910.2. — *Cyprinidæ.* Pictet, A. 1909.2. — *Ammocœtes.* Schaffer, J. 1895.1. — *Chimæra.* Studnicka, F. K. 1902.2.

Adenoid organ, a large lymphoid organ embedded in submucosa of œsophageal wall of Selachii. Drzewina, A. 1904.3, 1905.1, 1910.2; Kulchitzkii, N. 1911.1.

So-called "salivary" gland (of unknown function) of Petromyzon, only oral gland of the Ichthyopsida. Born, G. 1828.1; Giacomini, E. 1900.2; ★Haacke, J. W. 1903.1; Rathke, M. H. 1823.1, 1825.1; Reichel, P. 1882.1.

Description of a pair of lateral pharyngeal pouches in Scarus presumed to serve as reservoirs for food. Sagemehl, M. 1885.1.

Posterior openings of nares in pharynx of — Astroscopus. Dahlgren, U. 1908.2. — *Cynoglossus.* Johnstone, J. 1904.3; Kyle, H. M. 1900.6.

Morphology of the tongue in fishes. Chaine, J. 1900.2, 1901.1, 1902.2, 1907.1; ★Gegenbaur, C. 1894.1; ★Hörschelmann, – 1866.1.

For the "tongue-bone" or the basi-hyal element of the hyoid arch and its musculature, see under Visceral skeleton.

STOMACH

(As characterized by the presence of gastric glands, the Dipnoi and Cyprinidæ lack a true stomach.)

For the best systematic treatment, see ★Oppel, A. *cited above.*

Various papers on the structure of the stomach. Gregory, W. K. 1904.1; Gegenbaur, C. 1878.1; Hancock, J. 1830.1; Heusner, L. 1905.1; Ricci, N. 1875.1; Stricker, F. 1899.1; Supino, F. Add. 1914.1.

Structure of the stomach in — Cetorhinus. Home, E. 1809.1, 1813.1. — *Amia.* Hopkins, G. S. 1891.1. — *Salmonidæ.* Kner, R. 1851.1, 1852.1. — *Silurus.* Retzius, A. J. 1842.1. — *Trout and herring.* Williamson, H. C. 1896.1.

Histological structure of the gastric epithelium. Glinsky, – 1883.1; Kolster, R. 1907.1; Pilliet, A. H. 1893.1, 1894.1; Stirling, W. 1884.1; Biedermann, W. Add. 1875.1; Bischoff, T. W. Add. 1838.1.

Histology of the gastric or peptic glands. (Edinger concluded that these contain only one kind of cell which is not homologous with either the "central" or the "parietal" cells of the mammalian stomach.) Cattaneo, G. 1886.1,.3, 1892.1; Edinger, L. 1876.1; Monti, R. 1898.3; Nussbaum, M. 1882.1; Oppel, A. 1896.2; Valatour, M. 1861.1; Garel, J. Add. 1879.1.

Tunica Muscularis

(The muscular coat of the alimentary canal.)

Histogenesis of striated muscle in œsophagus of dogfish. McGill, C. 1910.1.

Taxonomic characters afforded by muscular sheath of œsophagus. Gulliver, G. 1842.1, 1870.2.

The muscular coat of the stomach and intestine in most fishes and in all other vertebrates consists of an inner circular and an outer longitudinal layer of smooth muscle fibers. However, in some teleosts, Cobitis (Misgurnus), Solea, Syngnathus, and Tinca, the striated fibers of the œsophagus are continued into the walls of the stomach and intestine where they are disposed in an inner circular and an outer longitudinal layer, in addition and external to the two inner layers of smooth fibers.

For a general discussion, see ★Oppel, A. 1896.1 (pt. 1, p. 44); *for conditions in Syngnathus, see* Pilliet, A. H. 1885.1; *discovery, in Cobitis.* Budge, J. Add. 1847.1.

Solea sp. has an inner striated circular layer and an outer smooth longitudinal layer. Oppel, A. 1896.1 (pt. 1, p. 77); Valatour, M. 1861.1.

Structure, histology, etc., of striated layers of intestine of tench, Tinca vulgaris.

Alimentary Canal — *Cont'd.*

Du Bois-Reymond, R. 1890.1; Molin, R. 1850.2; Oppel, A. 1896.1 (pt. 1, p. 74); Retterer, E. & Lelièvre, A. 1909.1.

Experimental results of induction current, curare, etc., reveal specific rapid and slow reactions respectively of striated and non-striated fibers. ★Mahn, R. 1898.1. — *Comment on this.* Wood, H. C. 1898.1.

INTESTINE

For a comprehensive general treatise, in German, see ★Jacobshagen, E. **1911.1.**

For a full review in French, see ★Yung, E. J. Add. 1899.1.

For the lymphatics of the intestine, see Special parts *under* Lymphatic *under* Circulatory system.

Variations in length of intestine, influence of food upon length, etc. Babák, E. 1903.1; Bloch, A. 1904.1.

Cloacal epithelium of Selachii. List, J. H. 1884.1, 1885.1, Add. 1884.1, 1886.1.

Peritoneum or serous envelope of the intestine in Pleuronectidæ. Sauvage, H. E. 1908.1.

Pigmentary cells of the intestine. Oppel, A. 1889.1.

Bursa Entiana or duodenal segment of the intestine of Selachii, anatomy. Redeke, H. C. 1900.1,.2.

Papers dealing primarily with the histological structure of the intestinal epithelium. Arcangeli, A. 1906.1–1909.1; Bizzozero, E. 1904.1; Drzewina, A. 1912.1; Edinger, L. 1876.1, Add. 1887.1; Fuhrmann, O. & Yung, E. (*Lota*) 1900.1; ★Pictet, A. 1909.2; Sullivan, M. X. 1905.1; Sundvik, O. 1907.1; Waalewyn, H. W. 1872.1; Yung, E. J. 1898.2; Garel, J. Add. 1879.1; Pogonowska, I. Add. 1912.1.

Other papers on the structure and development of the intestine. Cajetan, J. 1883.1; Cattaneo, G. 1886.2, Add. 1886.1,.2; ★Egounoff, S. 1907.1; Egounoff, S. & Yung, E. 1907.1; Gemmill, J. F. 1899.1; ★Howes, G. B. 1890.2,.3; Knauthe, K. 1897.1, 1898.1; Pilliet, A. H. 1885.1; Piper, H. 1902.3; Rathke, M. H. 1820.1, 1825.2; Reinhard, W. 1888.1; Grimm, J. D. Add. 1866.1; ★Maurer, F. Add. 1906.1.

Structure and development, including the histological structure of the epithelium in various groups of fishes.

Cyclostomata. — *Petromyzon.* Claypole, A. M. 1895.1. — *Myxine.* Cole, F. J. 1905.1 (v); Maas, O. 1899.1; Schreiner, K. E. 1899.1.

Dipnoi. — *Lepidosiren.* Ehlers, E. H. 1895.1. — *Neoceratodus.* ★Neumayer, L. 1903.1, 1904.1. — *Protopterus.* Laguesse, G. E. Add. 1890.1.

Ganoidei; Amia and Acipenser. Hilton, W. A. 1900.1; ★Hopkins, G. S. 1892.1, 1893.1, 1895.1; Macallum, A. B. 1886.1.

Selachii. Duvernoy, G. L. 1835.1; Helbing, H. 1903.1; Petersen, H. 1908.1. — *Scyllium.* Guieysse-Pellissier, A. 1911.1, 1912.1, 1913.1. — *Hypnos subnigrum.* Howes, G. B. 1890.3. — *Manta.* Mazza, F. 1891.1. — *Carcharias.* Steenstra-Toussaint, A. J. 1843.1.

Teleostei. — *Clarias.* Böhme, R. 1904.1. — *Clupea.* Day, F. 1882.2. — *Anarrhichas.* Haus, G. A. 1897.1. — *Macruridæ.* ★Krumbholz, J. 1910.1. — *Ameiurus.* Macallum, A. B. 1884.1. — *Regalecus.* Mazza, F. 1900.1, 1901.1. — *Teleostei.* Nusbaum-Hilarowicz, J. 1915.4. — *Cyprinidæ.* Pictet, A. 1909.1,.2. — *Plectognathi.* Rosén, N. 1912.1. — *Gadus.* Thesen, J. E. 1890.1. — *Luvarus.* Haller, B. Add. 1881.1.

Structure, including the intestinal epithelium, in the loach, Cobitis (Misgurnus). This form has capillary blood-vessel plexuses in the walls of the submucosa. Calugareanu, D. 1907.1; Eberth, C. J. 1862.1; Leydig, F. 1853.2; Lorent, H. 1878.1; Lupu, H. 1907.1, 1908.1, Add. 1909.1, 1914.1; Paneth, J. Add. 1889.1.

For the use of the intestine by Cobitis in breathing, see Intestinal respiration *under* Respiration.

Lateral position of vent in Amphioxus. Wilder, B. G. 1874.1.

Appendix Digitiformis or " Rectal gland "

Called also digitiform gland, processus digitiformis, and superanal gland. It is situated in the terminal portion of the intestine of Elasmobranchii and is possibly homologous with the cæcum coli of higher vertebrates.

Anatomy, development, and possible functions in Selachii. Blanchard, R. 1878.1,.2, 1882.2; Crawford, J. 1901.1; ★Howes, G. B. 1890.2; Mazza, F. 1898.1; Morgera, A. 1910.1, 1914.1; Pixell, H. L. 1908.1; Sanfelice, F. Add. 1889.1.

Structure in Chimæra. Mazza, F. & Perugia, A. 1894.1; Leydig, F. Add. 1851.1.

For references to the possibly homologous intestinal cæcum of some teleosts, see Howes, G. B. 1890.2; *see also* Budge, J. 1848.1.

Appendices pyloricæ or Pyloric cæca

Structure in Teleostei. Hyrtl, C. J. 1865.1; ★Kostanecki, K. 1913.1. — *Salmonidæ.* Cattaneo, G. 1900.1; Day, F. 1887.4,.5; Kner, R. 1851.1, 1852.1. — *Centrarchidæ.* Johnson, R. H. 1907.1. — *Centrolophus.* Riggio, G. 1894.2. — *Xiphias.* Rosenthal, F. 1824.1.

For the functions of the pyloric appendages, see Intestinal digestion *under* Digestion.

Pair of cæca of anterior part of intestine of Greenland shark (Læmargus). Gegenbaur, C. 1892.1; Turner, W. 1873.1.

Spiral Valve

Structure and development, chiefly Selachii. Duvernoy, G. L. 1833.1, 1835.1; ★Kantorowicz, R. 1897.1; Mayer, P. 1898.1; Neuville, H. 1897.3, 1901.2; ★Parker, T.J. **1885.1**; Rückert, J. 1896.1,.2.

Earliest references and figures. Alopias. Perrault, C. Pre-Linn. 1671.1. — *Raja.* Steno, N. Pre-Linn. 1664.2–1675.1.

Spiral valve in Plagiostomi and Ceratodus. (*Figures.*) Garman, S. 1913.1.

Coprolites or petrified fæces: fossilized moulds of the spiral valve, accompanying remains of fossil fishes. Dean, B. 1909.5; Leydig, F. 1896.1; Neumayer, L. 1904.2, 1914.1; Sacco, F. 1886.1; Fischer von Waldheim, G. Add. 1835.1.

Manner of formation of helicoidal fæces in Protopterus. Dean, B. 1903.4; Vaillant, L. L. 1896.6.

ANATOMY AND MORPHOLOGY

The present section includes only works on the general anatomy and morphology of fishes.

References to the structure and morphology of individual organs and systems, occur under these topics.

For the morphology of fossil fishes *see under* the fishes in the Systematic Section. *See also the section on* Palæontology.

For general accounts on the anatomy of fishes, with references to the literature, etc., see ★Bridge, T. W. 1904.1; ★Kerr, J. G. 1910.1.

Various topics; unity of the gnathostome type, ground plan of vertebrate structure, the morphological method, etc. Ayers, H. 1906.1; Hilgard, T. C. 1871.1; Jaekel, O. 1896.2, 1906.1; Kerr, J. G. 1906.1, 1910.2; Gill, T. N. Add. 1881.3.

Miscellaneous, unimportant, and unclassified items on the anatomy of fishes. Autenrieth, J. H. 1800.1; Batarra, G. 1771.1; Davy, J. 1839.2; Jaquet, M. 1894.1; Kuhl, H. & Hasselt, J. K. 1820.1, 1824.1; Monro, A. 1785.1, 1787.1; Newton, E. T. 1895.1; Rabuteau, A. P. & Papillon, F. 1874.1; Rawitz, B. 1882.1; Schneider, J. G. 1787.1, 1795.1; Stannius, F. H. 1839.1; Szibenliszt, M. 1841.1; Vicq-d'Azyr, F. 1776.1; Winkler, G. 1876.1.

Early writings on anatomy, references in Pre-Linn. *section.* ★Artedi, P. **1738.1**; Francese, G. G. 1625.1; Gering, J. 1727.1; Germano, F. 1625.1; Hebenstreit, J. 1733.2; Jacobæus, O. 1696.1–1710.1; Koenig, E. 1687.1; Leeuwenhoek, A. 1684.1–1694.1; Preston, C. 1698.1; Roberg, L. 1749.1; ★Scheuchzer, J. J. 1703.1; Steller, G. W. 1753.1.

Comparative anatomy of vertebrates

(Text-books, manuals, handbooks, etc., on comparative anatomy including fishes).

Text in English. Cuvier, G. L. 1802.1; Gegenbaur, C. 1878.2; Home, E. 1814.1; Huxley, T. H. 1871.1; Jones, T. Rymer, 1861.1; Kingsley, J. S. 1912.1; Parker, T. J. 1884.1; Rolleston, G. 1870.1, 1888.1; Todd, R. B. 1859.1; Owen, R. 1846.1, 1866.3; ★Wiedersheim, R. E. **1897.1**. — Pre-Linn. *treatises.* Collins, S. 1685.1; Monro, A. 1744.1.

Text in French. Chatin, J. 1880.1; Cuvier, G. L. 1800.1, 1817.1, 1829.1, 1836.1; Edwards, H. M. 1857.1; Humboldt, F. H. & Bonpland, A. J. 1805.1; Vialleton, L. 1911.1; Vogt, C. C. & Yung, E. 1888.1; Carus, C. G. Add. 1833.1.

Text in German. Brandt, A. T. 1911.1; Brül, C. B. 1877.1; Carus, C. G. 1818.1; Cuvier, G. L. 1809.2, 1831.1, 1846.1; ★Gegenbaur, C. 1859.1, 1864.3, 1870.1, 1874.1, 1878.3, 1898.1; ★Haller, B. 1904.1; Humboldt, F. H. & Bonpland, A. J. 1806.1; Kuhl, H. 1820.1; Mayer, A. F. 1835.1; Nuhn, A. 1878.1; Schneider, A. F. 1879.1; Siebold, C. T. & Stannius, F. H. 1845.1, 1846.1, 1854.1; Stannius, F. H. 1846.2,.3; Vogt, C. C. & Yung, E. 1885.1; ★Wiedersheim, R. E. 1884.1, 1886.1, 1898.1, 1906.1; Schimkewitsch, W. Add. 1910.1.

Text in Italian. Canestrini, G. 1869.1; Doria, G., Ferrari, S. M. & Lessona, M. 1861.1–1869.1.

Text in Latin. References in Pre-Linn. *section.* Bartholinus, C. 1611.1; Blasius, G. 1667.1–1681.1; Commelin, C. 1667.1; Fabri, P. J. 1656.1; Severinus, M. A. 1645.1; Valentini, M. B. 1720.1; Wotton, E. 1552.1.

ANATOMY AND MORPHOLOGY

OF THE FOLLOWING GROUPS
OF FISHES

CEPHALOCHORDATA

(The Leptocardii or Lancelets,
marine acraniate chordates.)

General treatises. Cooper, C. F. 1903.1; ★Delage, M. Y. & Hérouard, E. 1898.1; ★Lönnberg, A. J. **1901.5**.

Anatomy of Amphioxides,
a pelagic form

Researches. Gibson, H. O. 1910.1; ★Goldschmidt, R. Add. **1905.1**.

Anatomy of Amphioxus,
a littoral form

General treatises. ★Burchardt, E. **1900.1**; ★Herdman, W. A. 1904.1; Rohon, J. V. 1882.2; ★Rolph, W. 1875.3; Stieda, L. 1873.1,.3; ★Willey, A. **1894.1**; Thomson, J. A. Add. 1912.2.

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Various short articles. Lister, J. L. 1879.1; Lord, W. B. 1862.1, 1863.1; Anon. 49; Hudson, F. Add. 1888.1.

ANGLING FOR SALMON AND TROUT

General treatises. Fitzgibbon, E. & Young, A. 1850.1; Russell, H. 1911.1; Schubart, A. 1907.1; Wells, H. P. 1886.1, .2; Younger, J. 1860.1, Add. 1864.1; Clarke, K. Add. 1889.1; ★Hardy, J. J. Add. **1907.1**; Hodgson, W. Add. 1904.1, 1906.1, 1907.1; Cotton, C. Pre-Linn. 1676.1.

Short popular articles. Baird, S. F. 1871.38, 1873.45; Barrington, C. G. 1906.1; Barton, E. L. 1900.1; Bennett, T. 1874.1; Cartwright, W. 1874.1; Conway, J. 1861.1; Herbert, H. W. 1853.1; Hutchinson, H. G. 1904.1; Matthey, A. 1883.1; Armistead, W. H. Add. 1908.1; Dawson, G. Add. 1876.1; Hallock, C. Add. 1890.1; Stewart, W. C. Add. 1877.1; Wilkinson, A. G. Add. 1883.1.

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Canada. D., C. U. 1874.1; Gregory, J. U. 1873.1; Hardy, C. 1869.1; King, W. R. 1866.1; Philips, B. 1874.7; Burroughs, J. Add. 1883.1.

United States. Bean, T. H. 1890.13; Dinsmore, A. H. 1902.1; Holder, C. F. 1908.6; Locke, W. M. 1878.1; Weidmayer, M. C. 1885.1; Gregg, W. H. Add.

Angling — *Cont'd.*
1902.1; Harris, W. C. Add. 1885.1; Muller, J. W. Add. 1909.1; Northrup, A. J. Add. 1903.1; Vachell, H. A. Add. 1901.1. — *History of the Schuylkill Fishing Company, Philadelphia.* Milnor, W. 1830.1, 1889.1.

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PRINCIPAL AQUARIA

Of the world

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List of fishes exhibited at Giza, Egypt. Flower, S. S. 1904.1, 1910.1. — *Management of public aquaria.* Mather, F. 1880.1. — *Aquarium in Australia.* Stead, D. G. 1911.1.

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Netherlands. Amsterdam Aquarium. Pellegrin, J. 1909.1.

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Aquaria of the United States. *California, Los Angeles.* Edwards, C. L. 1912.1.

— *San Francisco. Woodward's Aquarium.* S., O. 1877.1.

Massachusetts, Boston. Gray, A. F. 1875.1.

The New York Aquarium. Bean, T. H. 1897.2, 1898.2; Bristol, C. L. 1901.1, 1903.1; C., A. P. 1877.1; H., F. 1876.1; Mowbray, L. L. 1910.1; Osburn, R. C. 1910.1,.2, 1911.7,.8, 1912.4; Shufeldt, R. W. 1901.4, 1903.5, 1907.3, 1915.1; ★Townsend, C. H. 1903.1, 1905.1, 1906.2.

U. S. Fish Comm. Aquarium, Washington. Reeves, I. S. 1894.1; Seal, W. P. 1892.1; Shufeldt, R. W. 1897.2, 1899.1.

AQUARIUM FISHES

This section primarily contains references to the fishes which are commonly kept in aquaria, and to those rare or uncommon species which have occasionally been introduced from foreign lands and exhibited in aquaria.

Many of these papers are merely notices of the exhibition of certain species; others in addition contain remarks on their appearance, their habits while under observation, their nesting or breeding habits, etc.

In no nation has there been developed a greater interest in aquarium fishes than in Germany. The great majority of the following references have appeared in the German aquarium journals. Among these, especial mention may be made of the "*Wochenschrift*" and the "*Blätter für Aquarien und Terrarienkunde.*"

Many species of fishes have been introduced in various countries for the purpose of acclimatization. For these, *see* Introduction and acclimatization *under* Pisciculture.

For the care of fishes in ponds, *see* Pond Culture *under* Pisciculture.

For a comprehensive general work on aquarium fishes, comprising the majority of those listed herein, see Bibliothek für Aquarien- und Terrarienkunde, Braunschweig, 1908–14, Heft. 1–37.

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Ceratodus. Dean, B. 1906.2, 1912.2; O'Connor, D. 1898.1,.2; Ramsay, E. P. 1871.1, 1876.1; Sclater, P. L. 1898.1, 1906.1; Semon, R. W. 1908.1.

Lepidosiren. Bartlett, A. D. 1856.1; Goeldi, E. A. 1898.3; Meerwarth, H. 1897.1; Müller, F. 1877.1; Wilson, F. W. 1867.1.

Protopterus. Bolau, C. C. 1910.1; Bräunle, E. 1911.1; Duméril, A. H. 1866.5; Gray, J. E. 1856.1; Harting, P. 1858.1; Krauss, F. 1864.1; Lachmann, H. 1891.1; Marno, E. 1873.1; Shufeldt, R. W. 1901.1; Dean, B. Add. 1913.1.

ELASMOBRANCHII

Torpedo in Berlin aquarium. Du Bois-Reymond, E. H. 1884.1.

For other Elasmobranchii in aquaria, see under Spawning *in section on* Reproduction.

GANOIDEI

Acipenser. Baird, S. F. 1874.23; Kammerer, P. 1907.7; Solotnizky, N. F. 1901.2; Zolotniskiĭ, N. F. 1902.3.

Amia. Bade, E. 1898.1, 1902.1; Haffner, C. 1912.3; Hesdörffer, M. 1901.1; Sprenger, W. 1901.1.

Calamoichthys. Jürgens, W. Add. 1906.1.

Lepidosteus. Bade, E. 1899.5; Schreitmüller, W. 1915.10.

TELEOSTEI

Acanthopterygii

Blenniidæ

Blenniidæ in general. Emeljanenko, P. E. 1909.3. —*Blennius.* Kammerer, P. 1903.1; McIntosh, W. C. 1906.2; Rembold, R. 1909.1, Add. 1906.1; Rheinhold, R. 1906.1.

Centrarchidæ

For an extensive account of Centrarchid fishes in aquaria, *see* ★Engmann, P. 1911.2.

Centrarchidæ in general. Marsson, M. 1897.1.

Acantharchus. Mayer, F. 1912.1.

Apomotis. Milewski, A. 1915.1; Schreitmüller, W. 1913.1.

Ambloplites. Schreitmüller, W. 1912.15.

Centrarchus. Engmann, P. 1908.1; Finck, M. C. 1911.4; Holtzsche, P. 1910.1.

Enneacanthus. Bade, E. 1898.2; Bernhard, P. 1914.1; Brüning, C. 1910.3; Finck, M. C. 1913.1; Jüngling, R. 1909.1; Liebig, T. 1910.1; Pajeken, E. E. 1915.2; Weltner, W. 1897.1.

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Chætodontidæ

Chætodon. Müllegger, S. Add. 1906.1.

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Cichlidæ

For the best general work on Cichlids as aquarium fishes, *see* Engmann, P. 1911.1.

General accounts. Conn, C. 1913.1; ★Engmann, P. 1909.5, Add. 1911.1;

Aquarium Fishes — *Cont'd.* Gondermann, K. 1912.1; Klapproth, A. 1909.1; Milewski, A. 1915.5; Osburn, R. C. 1910.2; Pellegrin, J. 1906.3.

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Cichlasoma. Arnold, J. P. 1911.7, 1913.3–1913.6, Add. 1914.2; Aubry, O. 1913.1; Borchardt, F. 1913.1; Krüger, B. 1912.2; Rachow, A. 1912.2,.3, 1914.3; Reitz, A. 1911.2; Reuter, F. 1914.1; Schultheis, H. 1909.1; Stang, C. 1913.1; Höpfner, F. Add. 1914.1.

Crenicichla. Marré, E. 1911.1; Rachow, A. 1912.4, 1913.6; Brüning, C. Add. 1914.8.

Etroplus. Hohmann, K. 1913.1; Mazatis, F. 1910.1; Reichelt, J. 1906.3; Stang, C. 1913.1; Zimmermann, –. 1911.1.

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Haplochromis. Liebig, T. 1912.3; Reuter, F. 1912.3; Schreitmüller, W. 1912.7.

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Heros. Arnold, J. P. 1911.17, 1913.6; Bade, E. 1899.1; Finck, M. C. 1911.2; Melnikov, V. S. 1902.1; Schmidt, W. 1903.1; Steglich, E. 1912.1; Zimmermann, – 1907.1; Engmann, P. Add. 1911.1; Liebig, T. Add. 1914.1.

Heterogramma. Arnold, J. P. 1909.2, 1910.2, 1913.14; Dreyzehner, – 1912.1; Marré, E. 1909.1; Merwar, L. 1913.1; Schulze, L. 1912.1.

Mesonauta. Grabau, H. 1912.1; Meier, A. 1915.1; Muhl, K. 1913.1; Stansch, K. 1912.2; Weinhausen, H. 1911.2.

Nannocara. Arnold, J. P. 1912.16.

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Cottidæ

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Dormitator. Mikolay, A. 1909.1; Rachow, A. 1913.8; Reuter, F. 1911.1.

Eleotris. Arnold, J. P. 1911.10, 1913.9, .10; Brüning, C. 1902.1; Reichelt, J. 1906.2; Reuter, F. 1913.1, 1914.4; Schreitmüller, W. 1913.3, 1915.8; Schröder, W. Add. 1906.1.

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General account. Arnold, J. P. 1912.9.

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Polycentropsis. Arnold, J. P. 1906.3, 1908.2, 1912.22; Brand, F. N. 1910.1; Krasper, E. Add. 1914.1.

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Osphromenidæ

For the most comprehensive work on Macropodes in aquaria, *see* Stansch, K. 1907.1.

Betta pugnax (the fighting fish of Siam). Arnold, J. P. 1904.2; Bade, E. 1898.3; Bause, B. 1897.1; Braun, J. O. 1908.1;

Braunschweig, K. 1910.1; Butscher, A. 1901.1; Carbonnier, P. 1874.2 ; Dobelmann-Degerloch, H. 1899.1; Hipler, J. 1913.1,.2, Add. 1914.1; Hoffmann, E. 1913.1; Jürss, H. 1911.1; Krüger, Alfred, 1912.1; Liebig, T. 1912.2; Milewski, A. 1915.10; Noetzel, T. 1898.2; Pittrich, B. 1907.2; Rachow, A. 1914.7; Regan, C. T. 1910.3; Reuter, F. 1911.2; Schäfer, K. 1913.1; Träber-Klotsche, G. 1912.4; Anon. 314; Conn, C. Add. 1914.1; Fabre-Domergue, P. Add. 1914.1.

Ctenops. Arnold, J. P. 1904.1,.5, Add. 1914.5; Bartels, F. 1910.1; Finck, M. C. 1910.2; Kummer, H. 1904.1; Schäfer, P. 1915.1; Schiebold, A. 1912.1.

Macropodus (a domesticated variety of Polyacanthus). Bedriago, J. 1874.1; Butscher, A. 1900.1; Finck, M. C. 1911.3; Geyer, H. 1910.1; Heynhold, P. 1912.3; Langer, – 1877.1; Sasse, A. 1878.2; Sauer, –. 1913.1; Schäfer, P. 1915.2,.3; Schlömp, V. 1900.1; Schreiber, E. 1878.1; ★Stansch, K. 1907.1; Strixner, G. 1914.1; Wackenheim, M. 1912.1; Wrede, T. 1909.1; Zimmermann, –. 1911.2; Arnold, J. P. Add. 1914.6; Geyer, H. Add. 1914.1.

Osphromenus. Bade, E. 1897.1, 1912.2; Carbonnier, P. 1874.2; Engmann, P. 1901.2; Hohmann, K. 1912.2; Köhler, W. 1905.3; Lachmann, H. 1901.1; Langer, – 1877.1; Lehnert, K. 1910.1; Liebig, T. 1909.2; Marré, E. 1910.6; Melnikov, V. S. 1902.2, 1903.1; Reichert, J. 1906.1; Stansch, K. 1909.4; Geides, H. Add. 1914.2; Reichelt, J. Add. 1906.1.

Parosphromenus. Jürss, H. 1912.1.

Polyacanthus. Brüning, C. 1904.1; Duerigen, B. 1882.1, 1897.2; Engmann, P. 1909.4; Hélot, P. 1876.1; Pittrich, B. 1904.1; Pobowski, E. 1880.1; Reitz, A. 1910.2; Sasse, A. 1878.2; Schreitmüller, W. 1910.12; Stansch, K. 1911.10; Vogt, C. C. 1875.2; Weis, A. 1878.1.

Trichogaster. Arnold, J. P. 1904.4, 1911.24, 1912.29; Ehnle, H. 1910.11; Eter, P. 1913.1; Finck, M. C. 1910.5; Hohmann, K. 1911.3; Milewski, A. 1913.8; Noetzel, T. 1898.1; Reuter, F. 1912.2; Schäfer, P. 1915.1; Schreitmüller, W. 1912.10; Schulze, L. 1913.3; Stansch, K. 1909.2,.4; Steinhausen, A. 1904.1; Brüning, C. Add. 1914.17.

Percidæ

Acerina. Geyer, H. 1902.1; Sprenger, W. 1900.3.

Alvordius (Hadropterus). Schmitz, W. 1901.2; Sprenger, W. 1900.1.

Etheostoma. Rachow, A. 1911.14.

Perca. Reitmayer, C. A. 1912.1; Rost, G. 1914.1; Sprenger, W. 1900.3.

Serranidæ

Ambassis. Gerlach, G. 1909.1; Stansch, K. 1913.2; Träber-Klotsche, G. 1910.1; Anon. 34; Engmann, P. Add. 1911.2.

Apogon. Osburn, R. C. 1910.5.

Epinephelus. Osburn, R. C. 1912.2.

Therapon. Steiner, M. 1910.1.

Various genera belonging to other families of Acanthopterygii

Agonus. Müllegger, S. 1913.2. — *Aphredoderus*. Hesdörffer, M. 1902.2; Sprenger, W. 1901.5. — *Callionymus*. Müllegger, S. 1913.2; Newman, E. 1873.2. — *Capros*. Crane, A. 1879.1. — *Chrysophrys, Pagellus, and Sargus*. Beaux, O. 1910.1. — *Coris*. Birchall, E. H. 1876.1. — *Lepadogaster*. Hughes, W. R. 1864.1. — *Mullus*. Helder, W. 1899.2. — *Paraglyphidodon*. Arnold, J. P. 1912.17. — *Pleuronectes*. Koch, M. 1912.1; Schmidt, E. 1912.1; Zolotniskiĭ, N. F. 1906.1. — *Psettus*. Brüning, C. 1913.3; Milewski, A. 1914.5, 1916.3. — *Scomber*. Francis, F. 1872.1; Hallock, C. 1873.2; Smith, John Alexander, 1867.4. — *Selene*. Arnold, J. P. Add. 1914.1. — *Toxotes*. Zolotniskiĭ, N. F. 1902.1,.2.

Anacanthini

Lota (family Gadidæ). Kammerer, P. 1906.2; Milewski, A. 1914.1; Haffner, C. Add. 1914.1.

Apodes

Anguilla. Barfod, H. 1902.2; Bretagne, C. 1876.1; Haffner, C. 1911.1; Krause, Richard, 1911.1; Wiehle, E. 1910.1.

Catosteomi

Amphisile (family Amphisilidæ). Sokolovsky, A. 1916.1.

Gasterosteus (family Gasterosteidæ). Bolau, C. C. 1905.1; Buck, E. 1875.1; Haas, H. J. 1908.2; Johannsen, W. 1912.1; Pander, H. 1912.1; Reitmayer, C. A. 1913.2; Rohrbacher, L. 1915.1; Schneider, F. 1909.2; Werner, Fritz. 1915.1; Wrede, T. 1909.2,.3; Becker, K. Add. 1907.1.

Syngnathidæ

Doryichthys. Brüning, C. 1911.2; Rachow, A. 1913.9.

Hippocampus. Dambeck, K. 1877.3; Townsend, C. H. Add. 1913.3.

Siphonostoma. Bade, E. 1899.9.

Syngnathus. Dambeck, K. 1877.3; Gienke, H. 1913.1.

Haplomi

Esox. Haffner, C. 1912.2; Rost, G. 1914.2; Schreitmüller, W. 1915.9,.12; Walter, H. 1912.1.

Umbra. Bade, E. 1897.2; Lorang, Ch. 1913.2; Reitmayer, C. A. 1911.4; Schreitmüller, W. 1913.7.

Labyrinthici

Labyrinthici. Bruhn, J. 1911.1; Finck, M. C. 1910.4; Mandée, R. 1907.1; ★Stansch, K. 1909.3.

Microcyprini

Amblyopsis (Mammoth cave blind-fish). Schreitmüller, W. 1915.2.

Pœciliidæ (Cyprinodontidæ)

Pœciliidæ in general. Brüning, C. 1910.2; Finck, M. C. 1910.3, Add. 1914.1; Frank, P. 1913.1; Gerlach, G. 1903.1;

Aquarium Fishes — *Cont'd.* Hohmann, K. 1912.6; Leonhardt, E. E. 1905.4; Marré, E. 1912.1; Peter, J. 1901.1; Ringel, E. 1911.1; Rost, G. 1914.4; Wichand, B. 1906.1; ★Arnold, J. P. Add. 1914.16,.19.

For the outstanding general works on the Cyprinodonts as aquarium fishes, *see* ★Stansch, K. 1909.1, 1911.6, 1912.1.

Alfaro amazonum and A. cultratum (*Petalosoma and Petalurichthys are synonyms*). Crandall, L. S. 1914.1; Rachow, A. 1911.18, 1913.15.

Anableps (*the four-eyed fish*). Brüning, C. 1910.2.

Belonesox belizianus. Arnold, J. P. 1910.1; Krüger, B. 1910.2; Reuter, F. 1912.1; Schick, C. 1912.1; Träber-Klotsche, G. 1911.1.

Characodon. Brüning, C. 1910.2.

Cnesterodon decemmaculatus. Butscher, A. 1901.2; Hencke, H. 1902.1; Kettler, – 1901.1; Matte, P. 1900.1, Add. 1900.1.

Cynolebias belloti. Arnold, J. P. 1911.19; Rachow, A. 1912.5; Rodewald, C. 1913.2; Träber-Klotsche, G. 1914.1.

Cyprinodon, chiefly C. dispar, C. fasciatus and C. variegatus. Arnold, J. P. 1912.6, Add. 1914.3; Baum, H. 1913.1; Findeis, G. 1909.1; Friedrich, M. J. 1911.1; Gerlach, G. 1911.2, 1912.6; Rachow, A. 1913.7; Schneider, F. 1909.1; Schulze, L. 1910.2, 1911.2; Unterberg, J. 1915.1; Vosseler, J. 1915.1; Wolterstorff, W. G. 1912.1; Stansch, K. Add. 1906.1.

Fitzroyia lineata (*Jenynsia*). Leonhardt, E. E. 1904.12; Rachow, A. 1913.15; Schreitmüller, W. 1910.6; Krüger, B. Add. 1914.2.

Fundulus, chiefly C. dispar, gularis, majalis, pallidus, and C. sjöstedti. Arnold, J. P. 1908.4, 1911.5,.13,.29, 1912.31, 1913.12,.13, Add. 1914.4; Bade, E. 1897.2; Ehnle, H. 1910.1; Fischer, H. 1910.1; Gellner, F. 1911.1; Gerlach, G. 1911.3; Kramp, E. 1913.2, Add. 1914.1; Krüger, B. 1913.6; Leonhardt, E. E. 1905.10; Mayer, F. & Rachow, A. 1911.1; Memmler, M. 1910.1; Milewski, A. 1913.3; Pugh, E. 1914.1; Rachow, A. 1911.4; Rauschenbach, W. 1912.1; Shufeldt, R. W. 1917.1; Stansch, K. 1911.12; Thumm, J. 1910.1; Träber-Klotsche, G. 1910.2,.3, 1911.2,.3, 1912.1; Woge, A. 1912.1; Wolterstorff, W. G. 1912.1.

Gambusia, chiefly G. affinis, G. episcopi, and G. holbrooki. Finck, M. C. 1912.1; Gerlach, G. 1912.2; Heede, C. J. 1912.1; Rachow, A. 1911.5; Sachs, J. 1913.1; Stansch, K. 1910.2; Stollreither, A. 1914.1; Tscheuke, W. 1904.1.

Girardinus. Stüve, H. 1901.1; Thumm, J. 1908.2.

Glaridichthys latidens. Leonhardt, E. E. 1907.4; Rachow, A. 1912.15; Schreitmüller, W. 1911.3.

Haplochilus of many species, chiefly H. cameronensis, chaperi, elegans, fasciolatus, latipes, melastigma, panchax, and H. rubrostigma. Arnold, J. P. 1906.4, 1907.3, 1908.1, 1911.6,.12,.30, 1912.12, Add. 1914.8; Aubry, O. 1912.1; Bade, E. 1898.5; Ehnle, H. 1910.2,.4; Eifert, E. 1910.1; Engmann, P. 1902.1; Finck, M. C. 1909.1, 1911.1, Add. 1914.1; Gerlach, G. 1911.4,.5, 1912.3,.4; Graichen, H. 1909.2,.3; Grohmann, J. 1909.1; Gruber, A. 1911.1; Homann, K. 1911.1; Kramp, E. 1913.1, Add. 1914.2; Liebers, A. 1913.1; Liebig, T. 1912.6; Liebscher, A. 1901.1; Lütge, A. 1905.1; Marré, E. 1909.2; Matte, P. 1901.2; Milewski, A. 1913.4,.5, 1915.4; Nicolai, E. 1910.1; Nieselt, E. 1910.1; Osswald, H. 1913.2; Rachow, A. 1912.10; Ringel, E. 1912.1; Rodewald, C. 1914.1; Sauer, – 1914.2; Schmitz, W. 1901.1; Schreitmüller, W. 1910.7, 1912.6; Schröder, W. 1906.3; Stansch, K. 1908.1,.2, 1910.3; Träber-Klotsche, G. 1911.5, 1912.2,.3,.5; Thumm, J. 1904.1, 1909.1; Wolterstorff, W. G. 1911.1, 1913.2; Zimmermann, – 1908.1; Zindler, A. 1914.1.

Heterandria formosa. Rachow, A. 1912.6,.16, 1913.10; Rost, G. 1914.5.

Jordanella floridæ. Mayer, Albert 1914.1; Rachow, A. 1914.8; Kierich, F. Add. 1914.1.

Lebias, chiefly L. sophiæ and L. iberus. Arnold, J. P. 1912.6,.15; Baum, H. 1913.1; Bierhance, E. 1912.1; Gerlach, G. 1911.2; Gienke, H. 1913.2; Rachow, A. 1913.7; Wolterstorff, W. G. 1912.1.

Lebistes reticulatus (*formerly called Girardinus guppyi and G. pœcilioides*). Arnold, J. P. 1909.1, 1912.10; Barfod, H. 1902.1; Both, E. 1910.1; Ehnle, H. 1910.7; Finck, M. C. 1910.1; Graichen, H. 1909.1; Hannik, P. 1911.1; Hippius, K. 1909.1; Köhler, W. 1906.1, 1910.1; Krüger, B. & Wolterstorff, W. 1910.1; Kuhnt, B. 1910.1; Liebscher, A. 1901.4; Mandée, R. 1907.2; Rachow, A. 1911.17; Schroot, W. 1901.2,.3; Schulze, L. 1911.1.

Limia. Eter, P. Add. 1914.1.

Lucania. Nichols, J. T. 1916.3.

Mollienisia, including M. latipinna, M. petensis, M. sphenops, and M. velifera. Ehnle, H. 1910.3; Friedrich, M. J. 1909.1; Hohmann, K. 1911.2; Lutz, J. 1914.1; Marré, E. 1913.1; Mayer, F. 1914.1; Mazatis, F. 1914.1; Rolle, W. 1910.1; Schreitmüller, W. 1913.5; Schroot, W. 1903.1; Brüning, C. Add. 1914.11,.12.

Phalloceros caudimaculatus. Liebig, T. 1909.3.

Phalloptychus januaris. Hey, F. 1909.1; Heynhold, P. 1912.2; Langner, A. 1910.1; Lorang, Ch. 1912.2; Riedel, K. 1910.1; Strieker, M. 1909.1; Träber-Klotsche, G. 1909.1, 1911.4; Wolterstorff, W. G. 1909.2, 1910.2,.3, 1911.2.

Platypœcilus maculatus. Gerlach, G. 1912.8; Hohmann, K. 1912.2; Hopdiquaks, – 1913.1; Leonhardt, E. E. 1908.2; Osswald, H. 1913.3; Schreitmüller, W. 1910.11,.16, 1911.7; Stansch, K. 1911.8; Wildner, E. 1912.3.

Pœcilia of various indeterminate species. Arnold, J. P. 1909.5, 1911.22, 1912.21,

.27, 1913.17; Bormann, A. F. 1910.1; Brüning, C. 1903.3; Finck, M. C. 1911.5; Gerlach, G. 1910.2; Lachmann, H. 1901.2; Leonhardt, E. E. 1905.19, 1906.11; Liebig, T. 1913.2; Marré, E. 1910.11; Matte, P. 1902.1; Rachow, A. 1910.4; Reichelt, J. 1910.2,.3; Stansch, K. 1907.2, 1911.9, 1913.5, 1914.1; Strieker, M. 1906.1, 1909.2; Thumm, J. 1907.3, 1909.4, 1910.2.

Pseudoxiphophorus bimaculatus. Ehnle, H. 1910.9; Funk, E. 1910.1; Gerlach, G. 1910.1; Zimmermann, – 1909.1.

Rivulus including R. flabellicauda, R. harti, R. ocellatus, R. poeyi, and R. tenuis. Arnold, J. P. 1912.25, 1913.20; Biehn, H. 1911.1; Börgershausen, W. 1910.1; Ehnle, H. 1910.10; Finck, M. C. 1911.7; Friedrich, M. J. 1910.1; Gerlach, G. 1909.2; Geyer, H. 1912.1; Hohmann, K. 1911.1, 1912.5; Langer, O. 1910.1; Mädel, S. 1910.1; Potempa, A. 1910.1; Reiss, E. 1912.1; Rost, G. 1913.5; Rozynski, P. 1909.1; Schäfer, K. 1914.1; Schreitmüller, W. 1912.4; Zindler, A. 1912.1.

Tomeurus. Rachow, A. 1911.16,.18, 1913.15.

Xiphophorus (Mexican Sword-tail), chiefly X. guentheri, X. helleri, and X. rachovii. Arnold, J. P. 1909.10; Ehnle, H. 1910.5; Gerlach, G. 1912.5,.7, 1913.1; Hartwig, W. 1912.1; Marré, E. 1910.13; Milewski, A. 1912.5; Osswald, H. 1912.2; Rachow, A. 1910.8, 1911.8, 1913.16; Regan, C. T. 1911.17, 1913.23, 1914.7; Reitmayer, C. A. 1915.5; Rost, G. 1913.4; Schiche, E. 1915.1; Wegner, J. E. 1913.1; Weinhausen, H. 1911.1; Wolterstorff, W. G. 1913.3, Add. 1914.1; Zimmermann, – 1909.2; Brüning, C. Add. 1914.3.

Zygonectes. Leonhardt, E. E. 1906.15.

Ostariophysi

Bunocephalus (family Aspredinidæ). Schröder, W. 1906.2.

Characinidæ

For the best general article on Characinidæ in aquaria, *see* Stansch, K. 1911.3.

General papers. Brüning, C. 1910.1, 1912.2; Mayer, F. & Rachow, A. 1910.1; Rachow, A. 1913.12; Reuter, F. 1916.1.

Acestrorhynchus. Rachow, A. 1914.1.

Alestes. Arnold, J. P. 1912.1.

Anostomus. Arnold, J. P. 1913.1; Schreitmüller, W. 1914.1.

Carnegiella. Krüger, B. 1913.2.

Characidium. Gellner, F. 1913.1; Rachow, A. 1913.2, 1914.9; Hecker, W. Add. 1914.1.

Chilodus. Rachow, A. 1913.3.

Chirodon. Harke, W. 1913.1; Heynhold, P. 1911.1; Rachow, A. 1911.9.

Copeina. Arnold, J. P. 1913.7.

Creatochanes. Rachow, A. 1914.1.

Erythrinus. Arnold, J. P. 1911.11.

Gasteropelecus (the fresh-water flying fish of South America). Krüger, B. 1913.2; Marré, E. 1910.4; Mayer, F. 1910.2; Milewski, A. 1916.1; Rachow, A. 1910.2.

Hemigrammus. Ellis, M. L. 1911.1; Liebig, T. 1912.4; Schreitmüller, W. 1912.11; Stansch, K. 1911.5.

Hydrocynus. Rachow, A. 1913.11.

Iguanodectes. Rachow, A. 1912.7.

Jobertina. Rachow, A. 1913.2.

Leporinus. Gellner, F. 1913.1; Krüger, B. 1913.3; Milewski, A. 1914.4, 1915.6; Rachow, A. 1910.9.

Lebiasina. Brüning, C. Add. 1914.9.

Macrodon. Arnold, J. P. 1911.18.

Metynnis. Wolterstorff, W. G. 1908.3; Stricker, M. Add. 1908.1.

Micralestes. Andres, Ad. 1913.1,.2.

Mimagoniates. Rachow, A. 1912.9.

Myletes. Liebig, T. 1913.3; Rachow, A. 1911.6; Schreitmüller, W. 1915.11.

Nannostomus. Rachow, A. 1910.3; Witting, E. 1911.1.

Neolebias. Rachow, A. 1911.7.

Paragoniates. Arnold, J. P. 1911.20; Rachow, A. 1911.10.

Petersius. Arnold, J. P. 1909.4, 1911.21; Jürss, H. 1913.1.

Phago. Arnold, J. P. 1912.20.

Poecilobrycon. Milewski, A. 1915.8; Rachow, A. 1911.11, 1913.13.

Pseudochalceus. Rachow, A. 1912.12.

Pseudocorynopoma. Ehnle, H. 1910.8; Leonhardt, E. E. 1906.12; Schreitmüller, W. 1915.5; Schulze, L. 1911.3.

Prochilodus. Arnold, J. P. 1912.23; Rachow, A. 1910.5; Reuter, F. 1914.3.

Pyrrhulina. Arnold, J. P. 1909.8; Kittler, O. 1907.1, 1909.1; Marré, E. 1910.8, 1911.2; Metzges, P. 1908.1; Rachow, A. 1911.12; Schäme, P. 1908.1; Schreitmüller, W. 1912.9; Stansch, K. 1912.4; Thumm, J. 1907.4; Windtrath, P. 1916.1; Wolterstorff, W. G. & Schäme, P. 1907.1; Stricker, M. Add. 1908.2.

Serrasalmo. Rachow, A. 1913.14.

Tetragonopterus. Blaue, O. 1911.1; Hohmann, K. 1912.4; Krüger, B. 1910.3, 1913.7; Leonhardt, E. E. 1907.7; Liebig, T. 1912.7; Marré, E. 1910.10; Mayer, F. 1911.1; Milewski, A. 1913.7; Potempa, A. 1911.2; Rachow, A. 1910.7; Schreitmüller, W. 1911.8, 1912.12, 1914.6; Stricker, M. 1909.3; Wendt, A. 1916.1.

Xiphoramphus. Arnold, J. P. Add. 1914.18.

Cyprinidæ

General accounts. Jürss, H. 1911.2; Brüning, C. Add. 1914.2.

Abramis. Schreitmüller, W. 1910.1.

Acanthocephalus. Arnold, J. P. 1911.1; Schreitmüller, W. 1910.2.

Alburnus. Klose, C. 1910.1; Schreitmüller, W. 1914.12, 1915.1.

Amblypharyngodon. Arnold, J. P. Add. 1914.1.

Aspius. Schreitmüller, W. 1914.2,.12.

Barbus. Arnold, J. P. 1912.3; Bade, E. 1905.1; Brüning, C. 1905.4, 1912.4, Add. 1914.3,.14; Finck, M. C. 1912.2; Gerlach, G. 1911.1; Köhler, W. 1905.2; Krüger, B. 1913.1; Rachow, A. 1910.1, 1911.1, 1912.14; Reichelt, J. 1906.1; Reitz, A. 1911.1; Rost, G. 1913.1, Add.

Aquarium Fishes — *Cont'd.*
1914.1; Schreitmüller, W. 1909.1, 1911.1, 1912.16, 1914.9, 1916.1; Schröder, W. 1906.1; ★Stansch, K. 1906.1, 1911.1,.2, Add. 1906.1; Stieler, W. 1905.1; Thomas, –. 1904.1; Trog, E. 1913.1; Wendt, A. 1916.2; Westphal, F. 1905.1; Andres, Ad. Add. 1914.1; Hermann, F. Add. 1906.1.

Barilius. Andres, Ad. 1913.1,.2; Stuyvenberg, H. 1913.1.

Capoëta. Marré, E. 1910.2; Rost, G. 1913.2.

Chelæthiops. Andres, Ad. 1913.1,.2.

Chondrostoma. Schreitmüller, W. 1914.4.

Chrosomus. Rachow, A. 1912.1.

Cobitis. Haffner, C. 1911.3; Köhler, W. 1909.1; Lauppe, L. 1903.1; Meixner, –. 1915.1; Reitmayer, C. A. 1915.3; Schnee, S. 1905.2; Sprenger, W. 1900.6; Thumm, J. 1905.2; Veesenmeyer, –. 1863.1.

Danio. Arnold, J. P. 1911.8,.9, 1912.7; Baum, H. 1910.1, 1912.1; Dallmann, G. 1911.1; Hänig, K. 1912.1; Hartwig, W. 1908.1; Kozlov, D. 1905.1; Leonhardt, E. E. 1906.3; Liebig, T. 1906.1; Lorang, Ch. 1913.1; Milewski, A. 1913.2; Osswald, H. 1912.1; Rachow, A. 1911.2; Reitmayer, C. A. 1916.2; Reitz, A. 1911.3; Rost, G. 1913.3; Schreitmüller, W. 1911.10,.13, 1912.8,.13; Schulze, L. 1913.1; Stahl, H. 1910.1; Wildner, E. 1912.1,.2; Herold, B. Add. 1914.1.

Gobio. Kleine, M. 1912.1; Reitmayer, C. A. 1911.2, 1915.4.

Lepidocephalichthys. Köhler, W. 1905.2.

Leucaspius. Engelmann, H. 1910.1; Kammerer, P. 1909.2; Schreitmüller, W. 1910.17; Wolterstorff, W. G. 1910.1.

Leuciscus. Gramsch, E. 1909.1; Kammerer, P. 1909.2,.3; Rachow, A. 1912.8; Reitmayer, C. A. 1913.1; Schermer, E. 1915.3.

Misgurnus. Rost, G. 1914.3; Schreitmüller, W. 1913.8; Köhler, W. Add. 1906.1.

Notropis. Rachow, A. 1914.5; Shufeldt, R. W. 1917.1.

Nuria. Bock, R. 1914.1; Osswald, H. 1914.1; Pfeiffer, K. 1910.2; Schreitmüller, W. 1911.11, 1914.8; Stoll, A. A. 1906.1; Anon. 423.

Phoxinus. Bade, E. 1899.2; Reitmayer, C. A. 1911.1.

Rasbora. Arnold, J. P. 1911.25, 1912.24, 1913.18; Bormann, A. F. 1910.2; Brüning, C. 1911.5; Liebig, T. 1911.1; Marré, E. 1910.9; Rachow, A. 1911.13; Reichelt, J. 1906.7, 1910.4; Schulze, L. 1912.3; Schreitmüller, W. 1910.13; Stansch, K. 1910.5; Träber-Klotsche, G. 1911.7; Hammer, J. Add. 1914.1.

Rasborichthys. Arnold, J. P. 1913.19.

Rhinichthys. Brüning, C. 1904.2.

Rhodeus. Braun, P. 1901.1; Reitmayer, C. A. 1912.2.

Ræboides (*Epicyrtus*). Rachow, A. 1910.6; Schreitmüller, W. 1913.4.

Tinca. Bade, E. 1898.6; Kammerer, P. 1909.2.

Squalius. Schreitmüller, W. 1910.5.

It being impossible to separate the care and culture of the gold fish, Carassius auratus, in aquaria from its pond culture, the whole subject will be found under the family Cyprinidæ *in the systematic section.*

Gymnotidæ

Carapus. Schreitmüller, W. 1915.6.

Gymnotus. Arnold, J. P. 1913.24; Chiaje, S. delle 1847.1; Geoffroy-Saint-Hilaire, E. F. 1822.2; Palmstedt, C. 1842.1.

Rhamphichthys. Brüning, C. 1911.6.

Loricariidæ

General accounts. Brüning, C. 1910.5; Kaiser, E. 1910.2; Franck, P. Add. 1914.1.

Otocinclus. Arnold, J. P. Add. 1914.11.

Plecostomus. Milewski, A. 1915.7; Rachow, A. 1914.6; Stansch, K. 1912.3.

Xenocara. Arnold, J. P. 1912.32.

Siluridæ

Amiurus. Liebig, T. 1913.4; Lorang, Ch. 1912.1; Schreitmüller, W. 1910.3.

Callichthys. Brüning, C. 1910.5; Freund, L. 1912.1; Helder, W. 1899.1; Liebscher, A. 1904.1; Leonhardt, E. E. 1906.6; Reitz, A. 1910.1; Scheljuzhko, L. 1911.1; Schreitmüller, W. 1910.3.

Chrysichthys. Arnold, J. P. 1913.2.

Corydoras. Arnold, J. P. 1912.5, 1913.8; Freund, L. 1912.1; Haffner, C. 1911.2; Liebig, T. 1912.5; Rachow, A. 1913.5.

Clarias. Arnold, J. P. 1912.4; Boulenger, G. A. 1899.7; Kaiser, E. 1910.1; Schreitmüller, W. 1915.7; Schroot, W. 1901.1.

Eutropius. Rachow, A. 1911.3.

Gymnallabes. Arnold, J. P. 1912.11.

Macrones. Leonhardt, E. E. 1906.10; Schreitmüller, W. 1910.3; Brüning, C. Add. 1904.1.

Malopterurus. A., C. 1858.2; Brüning, C. 1908.1; Du Bois-Reymond, E. H. 1857.1,.2, 1858.1,.2; Schreitmüller, W. 1911.4; Solotnitzky, N. F. Add. 1900.1.

Pimelodus. Kaiser, E. 1910.3.

Pinoleus. H., W. 1899.1.

Rhamdia. Brüning, C. Add. 1914.16.

Saccobranchus. Frænkel, F. 1912.1.

Silurus glanis. Kammerer, P. 1907.3; Milewski, A. 1916.2; Meiselbach, M. 1913.1; Seliuzko, – 1908.1; Solotnizky, N. F. 1902.2.

Trachycorystes. Schreitmüller, W. 1915.7.

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Coregonus. Heuscher, J. 1898.1; Brüning, C. Add. 1914.13.

Marcusenius. Arnold, J. P. 1909.3; Schreitmüller, W. 1912.3.

Osteoglossum. Rachow, A. 1912.11.

Pantodon (*the fresh-water flying fish of Africa*). Arnold, J. P. 1906.2, 1907.2, 1911.4,.26,.27; Brüning, C. 1911.7; Lehmann, A. 1912.1; Marré, E. 1910.7; Peters, W. C. 1877.5; Schreitmüller, W. 1912.2; Schulz, J. 1911.1; Siegl, H. 1912.1, 1914.1,.2.

Phractolæmus. Brüning, C. 1912.3; Jürgens, W. 1910.1; Köhler, W. Add. 1906.2.

Tarpon atlanticus. Townsend, C. H. 1906.2.

Thymallus. Schreitmüller, W. 1913.6.

Xenomystus. Arnold, J. P. 1909.9; Schreitmüller, W. 1912.17; Wittig, F. 1913.2.

Percesoces

Agonostomus. Rachow, A. 1913.1.

Anabas. Arnold, J. P. 1912.2,.14, 1913.23; Brüning, C. 1905.2, 1911.1; Carbonnier, P. 1874.2; Knöpfler, F. 1909.1; Liebscher, A. 1901.2; Schröder, O. 1910.1; Vetterlein, R. 1914.1; Wendt, A. 1915.1; Meissen, K. Add. 1895.1.

Atherinichthys. Rachow, A. 1914.2.

Hemirhamphus. Nobis, J. 1913.1; Reichelt, J. 1906.6; Schreitmüller, W. 1910.8,.9, 1911.6; Stansch, K. 1910.4.

Mugil. Marré, E. 1910.3.

Plectognathi

Tetrodon. Arnold, J. P. 1904.3; Cohn, Fritz 1912.1; Kaiser, E. 1911.1; Leonhardt, E. E. 1904.19; Reichelt, J. 1906.8; Stansch, K. 1913.3; Thumm, J. 1907.5; Wolterstorff, W. G. 1908.2, 1909.1; Zolotniskiĭ, N. F. 1908.1; Anon. 402; Schäme, P. Add. 1907.1.

Teleostean fishes
of various sub-orders

Antennarius. Sokolovsky, A. 1915.1.

Mastacembelus. Jürgens, W. 1904.1; Leonhardt, E. E. 1905.18.

Symbranchus. Masi, L. 1910.1; Simon, E. 1914.1.

ARCHÆOLOGY

Exhibiting the part played by fishes in the life of prehistoric man.

An authoritative popular treatise on archæology, which may be used in connection with the following reference, is Henry Fairfield Osborn's, " Men of the Old Stone Age." New York, 1915.

For a readable general treatise on most of the topics comprised in this section, consult ★Rau, C. **1885.1.**

Old Stone Age or Upper Palæolithic culture stations of Europe. *Evidences of interest in, or use of, fishes by early man.*

"Reindeer period" as exhibited by caves of south-western France. — Pike engraved on bear's tooth from Sorde (Duruthy) grotto, Landes Dep't. Lartet, L. & Duparc, L. 1874.1. *— Reindeer and salmon engraved on antler from Lorthet, Hautes-Pyrénees.* Piette, E. 1904.1. *—Fish-bones, vertebræ, etc., in caves of Vézère valley of Dordogne.* ★Sauvage, H. E. 1870.1.

Fish remains found in rock-shelters, caverns and grottos, or culture stations of — Schweizersbild near Schaffhausen, Switzerland. Fatio, V. 1902.2; Keller, R. 1896.1. *—Furinha-grotto, Portugal.* Harlè, E. 1909.1. *—Ludmirov cavern, Hungary.* Knies, J. 1905.1. *— Arene Candide cavern, Italy.* Morelli, N. 1891.1. *—Grottos of Menton, Italy.* Rivière, E. 1880.1–1887.1. *— Romanelli grotto, Otranto, Italy.* Stasi, P. & Regalia, E. 1904.1. *—Swanscombe, Kent, England.* Stopes, C. 1903.1.

Animal remains, including a few fishes, in caves of Ireland. Scharff, R. F. 1903.1; Scharff, Ussher, and others 1906.1.

Fish remains found in kitchen middens or artificial shell heaps (probably neolithic) of —Jæderen district, Norway. Brögger, A. W. 1908.1. *—Hardanger uplands, Norway.* Grieg, J. A. 1911.1. *—Denmark.* Petersen, C., Winge, H. & Winge, O. 1888.1; Winge, A. H. 1903.1.

Prehistoric fishing implements. *Development or history of the fish-hook, harpoon, etc., based on bone, horn, and bronze specimens from the various European culture stations, especially those of the Swiss lake-dwellers and including the designs of the American Indian.* Abbott, C. C. 1872.3; Köhler, K. E.; Klunzinger, C. B. 1892.1,.3; Leonhardt, E. E. 1903.5; ★Philips, B. 1880.1, 1883.3, Add. 1883.1; ★Rau, C. **1885.1**; Anon. 221, 674; Christensen, R. Add. 1881.1; Hein, W. Add. 1912.1; Krause, E. Add. 1897.1, 1904.1; Lampert, – Add. 1914.1; Lubbock, J. Add. 1872.1; Schmitter, A. Add. 1911.1; Schultze, M. Add. 1914.1.

Prehistoric fishing in Japan. Kishinouye, K. 1911.2.

American archæology

The fish in ancient Peruvian art. Mead, C. W. 1909.1, 1916.1. *—Fish figures in pottery in Argentina.* Torres, L. M. 1907.1.

Aboriginal American harpoons. Mason, O. T. Add. 1902.1. *—Bone fish-hooks of Little Miami valley.* Putnam, F. W. Add. 1887.1, 1888.2.

Classical archæology

Fish portrayals in the Roman catacombs. Achelis, H. 1888.1. *—Greek vase-paintings showing fishes.* Morin-Jean 1911.1; Emerson, A. Add. 1914.1.

Drying fish by Egyptians, portrayed on tombs of Pharaohs. Boussac, P. H. 1909.1, 1910.1,.2.

Mummified fishes of ancient Egypt. Gal, F. G. 1902.1; Lortet, L. & Gaillard, C. 1903.1–1909.1; Lortet & Hugounenq 1901.1; Pellegrin, J. 1900.7.

For a valuable recent work in English, on Greek and Roman, Egyptian, Assyrian, and Jewish fishing; including the economic and religious uses of fishes by these peoples, see ★Wm. Radcliffe. "Fishing from the earliest times." London. 1921. 478 p. ills.

For a similar work in German, "Die Antike Tierwelt," see ★Keller, O. 1909.1.

AUDITORY ORGANS

Consisting in fishes of the membranous labyrinth and its parts.

For the functions of the membranous labyrinth, *see* Hearing and the Static Sense.

General treatises on the auditory organs. ★Ayers, H. **1892.1**; ★Retzius, M. C. **1881.2**; ★Weber, E. H. Add. **1820.1.**

Auditory Organs — *Cont'd.*

Important papers on the structure of the ear. ★Breschet, G. 1832.1, 1838.1; Canestrini, R. 1886.2; Dufossé, A. 1874.1; Fischer, C. E. 1862.1; Hasse, J. C. 1869.1, 1873.2; Vescovi, P. 1891.1.

Miscellaneous papers. Beard, J. 1884.1; Camper, P. 1763.1, 1774.1, Add. 1763.1, 1792.1; Comparetti, A. 1789.1; Cuvier, G. & Duméril, A. 1830.1; Duméril, A. M. 1832.1, 1835.1, 1858.1; Gegenbaur, C. 1886.1; Hunter, J. 1782.1; Koelreuter, J. G. 1772.1; Retzius, M. G. 1875.1; Scarpa, A. 1789.1; Webb, W. M. 1905.1; Geoffroy, E. F. Add. 1778.1, Pre-Linn. 1755.1; Vicq-d'Azyr, F. Add. 1781.1; Villeneuve, – Add. 1760.1, Pre-Linn. 1756.1; Casserius, J. Pre-Linn. 1601.1; Nollet, J. A. Pre-Linn. 1746.1.

Anatomy and histology

Anatomy of parts of labyrinth. — *Cupula terminalis.* Hasse, J. C. 1870.1 (*Cyprinidæ*); Hensen, V. A. 1878.1; Studnička, F. K. 1912.1 (*Petromyzon*). — *Sacculus.* Shepherd, C. E. 1914.1. — *Dimensions of semicircular canals.* Wulf, B. 1901.1. — *Nature of endolymph.* Doesschate, G. Add. 1914.1. — *Structure of "Cochlea" (Lagena), Esox.* Hein, J. P. Pre-Linn. 1671.1.

Anatomy of membranous labyrinth in various groups, *including histological structure. (Of Cyclostomes, Myxine has one semicircular canal, and Petromyzon two; all higher fishes three.)*

Cyclostomata. Ecker, A. 1844.1, 1854.2; Ketel, H. 1873.1; Krause, Rud. 1905.1, 1906.2; Müller, J. (*Myxine*) 1834.1; Ovsyannikov, F. V. 1864.1, 1865.1; Studnička, F. K. 1912.1.

Elasmobranchii. Buchanan, T. 1828.1; Everett, W. H. 1896.1; Retzius, M. G. 1878.1,.2, 1880.3; Stewart, C. 1906.1,.2.

Ganoidei and Dipnoi. — *Neoceratodus.* Burne, R. H. 1913.1. — *Ganoids.* Cisow, A. 1880.1. — *Calamoichthys and Polypterus.* Retzius, M. G. 1881.3.

Teleostei. Kuhn, A. 1877.1; Retzius, M. G. 1871.1,.3, 1875.1, 1880.3. — *Amblyopsidæ.* Eigenmann, C. H. & Yoder, A. C. 1899.1; Wyman, J. 1854.5. — *Mormyrus.* Fischer, L. H. 1854.1; Heusinger, C. F. 1826.1; Marcusen, J. 1864.1. — *Gastroblecus and Pimelodus.* Heusinger, C. F. 1826.1. — *Cyprinidæ.* Lang, G. 1863.1, 1864.1. — *Orthagoriscus.* Meek, A. 1904.4; Thompson, D. W. 1888.1. — *Lepidoleprus.* Otto, A. W. 1826.1. — *Rhadinichthys.* Parker, G. H. 1908.4. — *Exocœtus.* Tschernoff, N. D. 1909.1. — *Hypophthalmus.* Wright, R. R. 1885.4, 1886.1. — *Deep-sea fishes.* Bierbaum, G. Add. 1914.1.

Peripheral nerve terminations in the organs of hearing.

Peripheral termination of the eighth or auditory nerve in the epithelium (cristæ and maculæ acusticæ) of the ampullæ, sacculus, and lagena of the labyrinth. Hartmann, R. 1862.1; Lang, G. 1863.1, 1864.1; Morrill, A. D. 1896.1; Krause, R. 1896.1, 1905.1; Retzius, M. G. 1871.3, 1881.4; Rüdinger, N. 1870.1; Schulze, F. E. 1862.1; Mullenix, R. C. Add. 1909.1. — *In Leucopsarion.* Kató, H. 1911.1. — *In Petromyzon.* Tretjakoff, D. 1908.2.

See also, Auditory nerve *under* Nervous System, peripheral.

Development of membranous labyrinth

For a general account of development in all groups, see ★Krause, R. **1906.1.**

General researches. Mitrofanov, P. I. 1890.1; Poli, C. 1897.1; Sidoriak, S. 1899.1; Stummer-Traunfels, R. 1910.1; Wenig, J. 1913.1.

Development in various fishes. — *Ammocœtes.* Gaskell, W. H. 1898.1 (x); Norris, H. W. 1896.1. — *Torpedo.* Hellmann, – 1898.1. —*Teleostei.* Noorden, C. 1883.1; Wenig, J. 1911.1,.2.

Development of parts of the labyrinth. — *Ductus endolymphaticus.* Krause, R. 1901.1. — *Macula neglecta.* Okajima, K. 1911.1. — *Sacculus endolymphaticus.* ★Sterzi, G. 1909.1. — *Ampullæ in Ammocœtes.* Tretjakoff, D. 1908.1.

Connections with air bladder

Of the membranous labyrinth

Apposition of paired tubular prolongations of air bladder to outer surfaces of fibrous membranes closing vacuities in bony walls of periotic capsules. — *Notopterus.* Bridge, T. W. 1900.1. —*Lotella.* Parker, T. J. 1882.3.

Protruding outgrowths of utriculus or sacculus forming otolith chambers in contact with anterior tubular extensions of air bladder. — *Clupeidæ.* Beaufort, L. F. 1908.1; Ridewood, W. G. 1891.1; Tysowski, A. 1909.1. — *In certain Acanthopterygii.* Starks, E. C. 1908.2.

Weberian apparatus in Ostariophysi *consisting of modifications of parts of the first three vertebræ.*

The following historical résumé is abstracted from Baudelot, E. 1868.5. These bones were first noticed in the carp by Rosenthal. They were further described by Weber who homologized them with the mammalian auditory ossicles, calling them malleus, incus, stapes and claustrum. Meckel and later Brechet were also inclined to this view. This view was strongly opposed, however, by Geoffroy St. Hilaire, who considered them to be the modified ribs of the first, second and third vertebræ. Saagmans Mulder originally considered them as a part of the auditory apparatus, but later came to the conclusion that they were ribs or parts of the vertebral apophyses. Baudelot believed that these bones represent the superior arches of the first and second vertebræ, the inferior arch of the third and the os intercrural parted in two.

Morphology, general treatise. ★Sagemehl, M. **1884.1.** — *Discovery made known.* Weber, E. H. Add. 1820.1.

Morphology. General accounts. Baudelot, E. 1868.4,.5; Geoffroy-Saint-Hilaire, E. F. 1824.4,.6,.12,.13; Huschke, E. 1822.1; Pacini, F. 1846.1.

Anatomy in various families of fishes. — *Cyprinidæ.* Baudelot, E. 1873.1; Müller, A. 1853.1; Saagmanns Mulder, A. E. 1831.1; Nusbaum, J. 1881.1, 1882.1, 1908.1,.2; Sachs, M. M. 1912.1; Sidoriak, S. 1900.1; Yasui, K. 1905.1; Anon. 560. — *Cobitidæ.* Bloch, L. 1900.1; Nusbaum, J. 1899.1; Sidoriak, S. 1900.1. — *Siluridæ.* ★Bridge, T. W. & Haddon, A. C. 1889.1, **1893.1**; Reis, K. 1905.1; Reissner, E. 1859.2; ★Sørensen, W. E. 1890.1, 1895.1; Wright, R. R. 1884.2, 1885.3,.4, 1886.1.

Functions of the Weberian apparatus. Bonnier, P. 1895.1; Sørenson, W. E. 1895.1. — *Considered a manometric apparatus or pressure gauge.* Thilo, O. 1906.1, 1907.1,.2, 1908.2.

BEHAVIOR

Comprising the comparative psychology of fishes

For all reactions to chemical stimuli, acidity, alkalinity dissolved gases, etc., *see under* Physiology.

For auditory reactions, *see* Hearing; *for* olfactory reactions, *see* Smell, etc.

For the associations of fishes and invertebrates, *see* Commensalism and symbiosis.

For the care of their eggs and young by fishes, *see* Parental care, *under* Reproduction.

A delightful readable volume on animal behavior including much on fishes and a bibliography, is ★ " The animal mind " *by* Margaret Floy Washburn. New York, 2nd ed., 1917, 386 p.

For an illuminating treatise on animal behavior, see ★Watson, J. B. Add. **1914.1**; *for a general review,* ★Sanford, E. C. 1903.1; *for a related topic,* ★Baglioni, S. Add. 1910.1.

Accounts or narratives, depicting unusual actions or behavior.

Aquarium fishes, as affected by earthquake. Auer, C. 1909.1.

Weather prophets among fishes. Dankler, M. 1899.2; Gutmann, C. A. 1842.1. — *Pleuronectes.* Philippsen, H. 1913.1.

Misgurnus (Cobitis), the loach, so-called " weather-fish " or barometer-fish, supposed to foretell weather changes. Inwards, R. Add. 1898.1; Brückmann, F. E. Pre-Linn. 1741.1; Chapelle, - Pre-Linn. 1733.1; Clauder, G. Pre-Linn. 1687.1; Venzky, G. Pre-Linn. 1740.1.

Chub picking flies from cattle. Moodie, R. L. 1909.1. — *Fishes picking mites from skin of men who immerse purposely.* Anon. 235.

Trout leaps from flume into water below. Redding, B. B. 1879.3.

Reaction to their images in a mirror. Žežula, B. 1909.1.

Behavior of various types. *Chiefly instinctive.*

Activity and repose. Polimanti, O. 1911.2; Szymanski, J. S. 1914.1.

Instincts and reflexes. — *Miscellaneous.* Blanchard, C. E. 1866.1; Sutton, F. 1899.1; Kirby, W. Add. 1835.1. — *Larval Amia, and Anguilla.* Dean, B. 1896.3, 1912.2. — *Reflex of Gasterosteus.* Garrey, W. E. 1905.1. — *Amphioxus, behavior.* Hussakof, L. 1910.4. — *Reactions of embryos.* Paton, S. 1908.1. — *Brook trout fry.* White, G. M. 1915.1.

Interrelation of sensory stimulation. ★Parker, G. H. 1907.1, 1908.3.

Manifestation of anger, fear and other emotions. Day, F. 1878.4; Elmhirst, R. 1912.1; Keene, J. H. 1880.2; Whitmee, S. J. 1878.1. — *Hæmulon about to attack displays vivid red lining of the mouth.* Reighard, J. E. 1915.1.

Sensibility to pain. Bentley, C. S. 1881.1; Cholmondeley-Pennell, H. 1870.1.

Color perception. (*Color vision*) *Reactions or sensitivity to differences in wave-length. The following experiments show a choice of certain colored lights or backgrounds, without regard to associative processes.*

For experiments wherein color discrimination as shown by fishes is associated with an agreeable or disagreeable sensation (chiefly food), see below under Memory or retention.

For the influence of color perception in producing adjustment to surroundings, see Changes in coloration *under* Coloration.

Belief in the existence of reactions to color or wave-length, rather than intensity. Bauer, V. 1909.1–1911.1; ★Frisch, K. 1911.4–1913.1, Add. 1913.1, 1914.1; Goldsmith, M. 1912.1, Add. 1914.1; Graber, V. Add. 1884.1; Haempel, O. & Kolmer, W. Add. 1914.1.

Color sense considered non-existent; fishes perceive colors as shades of gray, exactly like a person totally color-blind. ★Hess, C. 1910.1, 1912.1, Add. 1913.1, 1914.1. — *Remarks on this.* Franz, V. Add. 1914.1.

Color perception (non-existent) in Amphioxus. Krause, W. 1897.1.

Early exp. on keeping fishes in vessels of different colors. Stark, James. 1830.1.

For a popular résumé in German of all phases of color perception, see ★Kafka, G. Add. 1914.1.

Theories concerning the anatomical basis for color vision. Fritsch, G. T. 1904.1; Lubosch, W. 1909.2; Patten, W. 1898.1.

Suggestion that luminosity of deep-sea fishes (alleged to produce colored lights) may imply color perception. Trojan, E. 1914.1. — *Artificial flies used by anglers, supposed to indicate color-sense.* Abbott, C. C. Add. 1884.1.

Galvanotaxis. *Reaction to electrical stimulus.* Alluaud, C. & Vlès, F. 1911.1; ★Breuer, J. 1905.1,.2; Fujita, M. 1906.1; Ramstedt, C. O. 1872.1.

Immunity of Fundulus eggs to electrical stimulation. Brown, O. H. 1903.1.

Geotropism. Loeb, J. Add. 1891.2. — *Influence of gravity on development.* Rauber, A. 1885.1.

Intelligence. *Various anecdotes, notes, and observations supposed by their writers to indicate "intelligence" in fishes.* Abbott, C. C. 1883.1; Clarke, S. C. 1880.2; Dambeck, K. 1878.1; Day, F. 1881.2; Franz, V. 1906.2, 1912.4; Gurley, R. R. 1902.1;

Behavior — *Cont'd.*
La Blanchère, P. R. 1870.3, 1876.1; Leonhardt, E. E. 1909.1; Lépinay, S. 1907.1; Moulton, L. M. 1880.1; Ohm, P. 1909.1; Rivera, E. 1905.1; Romanes, G. J. 1883.1; Willumsen, P. J. 1901.2; Faraday, F. J. Add. 1879.1.

Memory or retention. *Retention of an acquired or habitual response during a period of its non-performance.*

Habit formation; experiments on motor habits. — Pike learned not to dash into glass partition to secure prey on other side. Möbius, K. A. 1875.1. — *Denial of such learning, in flounders.* Bateson, W. 1889.1. — *Repetition of Möbius's experiment.* Triplett, N. 1901.1. — *Labyrinth habit of Fundulus.* Thorndike, E. 1899.1, Add. 1911.1. — *Maze learning by goldfish.* Churchill, E. P. Jr. *in* Journ. Animal Behavior, 1916, *vol.* 6, *pp.* 247–255.

Memory of colors, including color discrimination. The following experiments (★) involved the use of certain colored objects, papers, tubes, forceps, etc., enclosing food as a reward; other colors were not accompanied by food or were rendered disagreeable, as by Reighard. All observers agree in the retention of the associations formed. Frisch, K. 1913.1; Minkevich, R. 1912.1; Oxner, M. 1912.1–1912.5. Reighard, J. E. 1908.1; Uhlenhuth, E. 1911.1; Washburn, M. F. & Bentley, I. M. 1906.1; Zolotniskiĭ, N. F. 1901.3; ★Goldsmith, M. Add. **1914.1**; ★White, G. M. Add. **1919.1**.

Memory of form or shape. Persists longer than color memory. Goldsmith, M. Add. 1914.1.

Memory of places and directions. (Topographic memory.) Miscellaneous, role in migrations, etc.; Franz, V. 1911.7, Add. 1913.2; Thierfelder, A. 1911.1; Zur Mühlen, M. 1911.19; Anon. 317. — *Memory for nesting site in Blennius seems to be olfactory.* Piéron, H. 1914.1. — *Experiments.* ★Goldsmith, M. Add. 1914.1.

Observations and anecdotes supposed to indicate the existence of memory. Baumgardt, G. 1904.1; Crivelli-Serbelloni, G. 1901.1; Dankler, M. 1902.1; Dantan, L. 1904.1; Landois, H. 1897.1; McIntosh, W. C. 1898.2; Parville, H. 1897.1; Reeker, H. 1898.1; Anon. 287; Giard, A. Add. 1897.1; J., J. Add. 1897.1. — *Memory considered non-existent.* ★Edinger, L. 1899.1, 1911.1.

Phototaxis and phototropism. *Perception and reactions to white light.*

Experiments. ★Hess, C. 1909.1, Add. 1913.1, 1914.1; Polimanti, O. 1912.4; Eisig, H. Add. 1884.3; Freytag, G. Add. 1914.1.

Light perception and reactions in — Amphioxus. Krause, W. 1897.1, 1898.2; Hesse, R. Add. 1898.1–.3. — *Haplochilus.* Miehe, H. 1911.1,.2. — *Larval plaice.* Moore, B. 1909.1. — *Danio.* Mertens, R. 1915.1; Schulze, L. 1915.2. — *Periophthalmus.* Weve, H. 1913.1.

Integumentary nerves as photoreceptors. ★Parker, G. H. 1905.2, 1909.1,.2.

Reaction of eyeless (blinded) fish. Long, J. A. 1904.1. — *Reactions (negatively phototropic) of eyeless cave-fish, Amblyopsis.* ★Payne, F. 1907.1.

Phototaxis considered a product of normal reflexes under abnormal laboratory conditions. Franz, V. 1910.7,.8, 1911.1, .6,.8.

Influence of light upon periodical depth-migrations. Loeb, J. 1894.1, 1908.1. — *Influence on migrations of eel.* Petersen, C. G. 1907.1.

For the Biological significance of silvery coloration or lustre, *in relation to phototaxis, see* Miscellanea *under* Coloration.

Rheotaxis and rheotropism. *Response to water currents.* Franz, V. 1910.7. — *An optical reflex.* Lyon, E. P. 1905.1, 1909.1. — *Relation of labyrinth and lateral line organs to rheotaxis.* Steinmann, P. 1913.1, 1914.1, Add. 1914.1.

For the evidently instinctive response of migrating salmon to the current, see Pacific salmons *under* Salmonidæ. *See especially,* Rutter, C. 1902.1, 1904.1.

BLIND FISHES OF THE CAVES

For the blind fishes (par excellence) of Mammoth Cave, Kentucky, and of other caverns, *see under* Amblyopsidæ.

General treatise: Cave vertebrates of America. ★Eigenmann, C. H. **1909.2**.

Origin of cave faunas. Eigenmann, C. H. 1898.1; Garman, H. 1892.1; ★Packard, A. S. 1889.1, 1894.1; Loeb, J. Add. 1915.1.

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For the other component of the central nervous system, *see* Spinal cord.

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DIVISIONS OF THE BRAIN
TELENCEPHALON
or Fore-brain

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Inter-brain or Thalamencephalon

Morphology and phylogeny. Burckhardt, C. R. 1894.2. — *Optic thalamus, structure.* Gottsche, C. M. 1833.2. — *Thalamus, phylogeny.* Kappers, C. U. 1908.2.

Anatomy in various groups of fishes. — *Selachii.* Edinger, L. 1895.1. — *Teleostei.* Franz, V. 1912.2; ★Goldstein, K. **1905.1**; Keller, O. 1906.1.

Epiphysis cerebri. (*Called also pinealis and pineal body or gland.*)

For the most extensive treatises on the anatomy and histology of the epiphysis in fishes, see ★Cattie, J. T. **1881.1–1883.1.**

Anatomy and morphology. Dendy, A. 1907.2; Jaekel, O. 1903.3; Julin, C. 1887.1; ★Leydig, F. **1896.2**; Minot, C. S. 1901.1.

Morphology of epiphysis in various groups of fishes. — *Cyclostomata* (*Geotria and Petromyzon*). Dendy, A. 1907.3; Sterzi, G. 1905.1; Whitwell, J. R. 1888.1. — *Dipnoi and Ganoidei* (*Protopterus, Polyodon, Amia*). Burckhardt, C. R. 1891.2; Garman, H. 1896.1; Hill, C. 1894.1; Kingsbury, B. F. 1897.1. — *Elasmobranchii.* Cattie, J. T. 1881.1,.2, 1882.1; Ehlers, E. H. 1878.2; Purvis, G. C. (*Lamna*) 1892.1. — *Teleostei.* Hill, C. 1894.1; Klinckowström, A. (*Callichthys*) 1893.2; Terry, R. J. 1910.1.

Development of epiphysis. Julin, C. 1887.1. — *Amia.* Davis, B. M. 1896.1; Eycleshymer, A. C. & Davis, B. M. 1897.1. — *Coregonus.* Hill, C. 1891.1. — *Acanthias.* Minot, C. S. 1901.1.

Summary of literature concerning epiphysis. Davis, B. M. 1896.1.

Functions of epiphysis. Ahlborn, F. Add. 1884.1.

Pineal eye of Cyclostomata (called also Parietal eye), an organ with a close resemblance to an eye, possessing a retina and in some cases a lens. In the adult lamprey, two vesicles, a dorsal "pineal" and a ventral "parapineal" overlie the roof of the thalamencephalon. According to Studnička, these organs develop as evaginations of the brain roof, the parapineal anteriorly.

General discussions. Favaro, G. & Mozejko, B. 1913.1; Leydig, F. 1887.1,

1896.2; ★Studnička, F. K. 1893.1,.3, 1900.2, **1905.1.**

Various papers on the morphology and development. Ayers, H. 1891.1; Beard, J. 1887.1, 1888.6; Cope, E. D. 1888.2; Dendy, A. 1899.1; Frisch, K. (*Functions*) 1912.2; Locy, W. A. 1893.1; Ovsyannikov, F. V. 1891.1; Rohon, J. V. 1900.2; Carrière, J. Add. 1890.1.

Morphology in Geotria. ★Dendy, A. **1907.1,** 1907.2,.3. — *Mordacia.* Spencer, W. B. 1890.1. — *Myxine.* Studnička, F. K. 1899.6. — *Petromyzon.* Ovsyannikov, F. V. 1888.1, 1889.2; Retzius, M. G. 1895.4; Studnička, F. K. 1893.2, 1899.3; ★Tretjakoff, D. **1915.1.**

Hypophysis cerebri, *or pituitary body. An ectodermal diverticulum from the roof of the oral cavity; not properly a brain structure, but by common consent placed here.*

Anatomy and morphology. ★Haller, B. **1898.1;** Jaekel, O. 1903.3; Müller, W. Add. 1871.1 (ii); Stendell, W. Add. 1913.1. —*Lateral lobes.* Gentes, L. (*Torpedo*) 1908.4; Rossi, U. (*Selachii*) 1903.1. — *Glandular lobe.* Gentes, L. 1903.1. — *Posterior lobe.* Joris, H. 1908.1.

Anatomy in various fishes. — *Calamoichthys.* Bickford, E. 1895.1. — *Centroscymnus.* Pettit, A. 1906.1. — *Myxine.* Retzius, M. G. 1895.5. — *Petromyzon.* Sterzi, G. 1904.2,.3. — *Chimæra.* Aresu, M. Add. 1914.1.

Development. Goette, A. 1883.1; ★Müller, W. Add. **1871.1** (ii).

Development in various groups of fishes. Cyclostomata (*Petromyzon*). Scott, W. B. 1883.1; Sterzi, G. 1904.3. —*Elasmobranchii.* Chiarugi, G. (*Torpedo*) 1898.1, 1905.1; Gentes, L. (*lobes in Torpedo*) 1908.2-.5; Herring, P. T. 1911.1. —*Ganoidei* (*Amia*). Prather, J. M. 1900.1; Reighard, J. E. 1900.2; Reighard, J. E. & Mast, S. O. 1908.1; Smith, P. E. 1914.1. — *Teleostei.* Boeke, J. (*Murænidæ*) 1903.1; Lundborg, H. 1894.1.

Histology. Studnička, F. K. 1901.1; ★Stendell, W. Add. **1913.1;** Tilney, F. Add. 1911.1.

Phylogeny. Dohrn, F. A. (*Petromyzon and Teleostei*) 1882.1,.2 (ii & iii); Stendell, W. 1914.1; Ayres, H. Add. 1907.1.

Varia. — *Structure, Rathke's pocket.* Albrecht, P. 1884.2. — *Action of extracts of hypophysis.* Herring, P. T. 1908.1,.2. — *Relation of hypophysis to notochord, shark embryos.* Rabl-Rückhard, H. 1880.1.

Infundibulum, *a funnel-shaped outpushing of the floor of the diencephalon. Morphology and homology.* Boeke, J. (*Amphioxus*) 1902.3, 1908.1, 1914.1; Gemelli, F. A. 1906.1; ★Haller, B. **1898.1.**

Development. — *Murænidæ.* Boeke, J. 1901.1, 1902.1. — *Torpedo.* Gentes, L. 1908.1. — *Petromyzon.* ★Sterzi, G. **1904.3.**

Lobi inferiores, *or bilobed expansions of the ventral walls of the diencephalon. Morphology.* Chatin, J. 1889.1. —*Ganoids and Teleosts.* ★David, J. J. **1892.1.**

Saccus vasculosus, *a vascular sac in the floor of the third ventricle. Morphology and function.* — *A receptive nervous organ, not a gland.* Boeke, J. & Dammerman, K. W. 1910.1. — *A depth organ, morphology.* ★Dammerman, K. W. **1910.1.** — *Development.* Lundborg, H. 1894.1.

MESENCEPHALON
or Mid-brain

Anatomy, development, and physiology. Erchia, F. 1896.1. — *Teleosts.* ★Franz, V. **1912.2.** — *Teleostei and Ganoidei.* Miklukho-Maklai, N. N. 1870.1. — *Zoarces.* Pedaschenko, D. 1901.1, *Development of mid-brain.* 1901.2. — *Mesencephalon as center for sense of equilibrium.* Reisinger, L. 1915.1.

Optic lobes, *paired thickenings of the dorsal wall of the mid-brain. Anatomy.* Eichholtz, I. H. 1841.1; Manouélian, Y. 1899.1. — *Teleosts.* Auerbach, L. 1888.1, 1889.1; Philipeaux, J. M. & Vulpian, E. F. 1865.1; ★Radl, E. **1915.1.** —*Eyeless cave-fish, Amblyopsis.* Ramsey, E. E. 1901.1.

Histology. ★Barbieri, C. 1905.2, 1906.1; Bellonci, G. 1883.1; Ramon y Cajal, P. 1899.1.

Functions of optic lobes. Gómez Ocaña, J. 1908.1.

Tectum opticum, *that portion of the mid-brain which roofs over the optic vesicle. Anatomy and histology.* Aichel, O. 1901.1; Bellonci, G. 1880.2, 1882.1.

Torus longitudinalis, *a grooved ridge in the median portion of the roof of the mesencephalon. Morphology, phylogeny, etc.* Rabl-Rückhard, H. 1887.1; Sala, L. 1895.1; ★Sargent, P. E. 1903.2.

METENCEPHALON
or Cerebellum

Anatomy and morphology. Bellonci, G. 1879.2; ★Burckhardt, C. R. **1879.1;** Edinger, L. 1910.1; Falcone, C. 1893.1; Gurewitsch, M. J. 1905.1; Schaper, A. 1899.3; Treviranus, G. R. 1831.1. — *Corpus restiforme, a structure in the cerebellum.* Gehuchten, A. 1904.1.

Of various fishes. — *Petromyzon.* Clark, W. B. 1906.1. —*Scyllium.* Edinger, L. 1901.1. — *Teleosts.* Franz, V. 1911.4. — *Acipenser.* ★Johnston, J. B. **1898.1.** — *Mormyridæ.* Stendell, W. 1914.4.

Histology and histogenesis. — *Teleosts.* Baudelot, E. 1869.4; Ovsyannikov, F. V. 1864.2; ★Schaper, A. 1893.1, 1894.1, *Petromyzontidæ.* 1899.2, *Mustelus.* 1898.1.

Functions. — *Static function in larvæ.* Franz, V. 1912.3. — *As center for sense of equilibrium.* Reisinger, L. 1915.1.

MYELENCEPHALON
or Medulla oblongata

Anatomy. ★Kingsbury, B. F. **1897.2;** Meckel, J. F. 1836.1. — *Cyprinidæ.* Savouré, P. 1912.1.

Histology. Ovsyannikov, F. V. 1854.1. — *Petromyzon.* David, J. 1892.1. — *Acipenser.* ★Johnston, J. B. 1898.1,.2. — *Myxine.* Röthig, P. 1913.1. —*Lophius.* Zuikov, V. P. 1898.1.

Brain — *Cont'd.*

Physiology. —*Gustatory center.* Herrick, C. J. 1905.1, 1906.1; *Tactile center.* 1906.1; *Tactile center, Prionotus.* 1907.3. —*General center for orientation.* Polimanti, O. 1915.1. —*Effects of sectioning upon orientation.* Loeb, J. Add. 1891.1.

Generalia. —*Fasciculus communis system, Bdellostoma.* Ayres, H. & Worthington, J. 1908.1. —*Entrance of cranial nerves, Amia.* Droogleever Fortuyn, A. B. 1913.1. —*Entrance of motor nerves in Amia.* Fortuyn, A. B. 1912.1. —*Funicular nuclei.* Herrick, C. J. 1906.2, 1907.2. — *Vagal lobes in Gadus.* 1907.2. — *Accessory lobes, Orthagoriscus.* Vignal, W. V. 1886.1.

For electric lobes, centers of the electric nerves in Torpedo, see under Electric fishes.

INCERTÆ SEDIS

Various unclassifiable items. — *Nerve center connected with posterior bundle, commissure of Haller in Gasterosteus.* Baudelot, E. 1869.2. — *Degeneration of brain, Scyllium, (experimental researches).* Fornario, G. 1894.1. —*Eversion and inversion of parts.* Kappers, C. U. 1908.1. —*Weight of brain in relation to size of eye.* Lapicque, L. 1908.1; Lapicque, L. & Laugier, H. 1908.1.

Nomenclature of cavities. Parker, T. J. 1889.1. — *Significance of parts.* Stieda. L. 1873.2,.5. — *Arrangement motor roots and nuclei, Acipenser and Lepidosteus.* Theunissen, F. 1914.1.

Review of brain casts of various fossil fishes. Moodie, R. L. 1915.2. —*Brain casts of Eocene Siluroids.* Neumayer, L. 1913.1. —*Brain structures of various fossil fishes.* Eastman, C. R. Add. 1913.1.

CHEMISTRY (*BIOLOGICAL AND PHYSIOLOGICAL*)

The great majority of the experiments and researches of the biological chemists have been performed with subjects other than fishes. The following titles represent the subjects, in so far as they are known to us, wherein their investigations have touched upon the subject of fishes.

Reference may advantageously be made to the standard text books of physiological chemistry, such as Mandel's translation of Hammersten and Hedin.

For topics primarily physiological, *such as* anabolism, katabolism, and urea formation; for effects upon fishes of acids, alkaloids, salts in solution, and other foreign substances, *see under* Physiology.

For the nature of the gaseous content of the air bladder, *see under* Air bladder.

For the nature of pigments, *see under* Coloration.

For the composition of fish guano and cod-liver oil, *see* Fertilizer, *and* Oils *below* Economic products *under* Fisheries.

For albumen, basic proteins, nucleic acid, etc., in ova; composition of egg-cases of sharks, etc., *see under* Ova and ovum.

For histones and protamines, *see* Chemical composition *under* Spermatozoa.

For the occurrence of guanin in the skins of fishes, *see* Argenteum *under* Integument.

Guanin in retinal epithelium. Cunningham, J. T. & MacMunn, C. 1893.1; Kühne, W. & Sewall, H. 1880.1.

Glycogen in various tissues, especially in the liver and muscles. Blanchard, R. 1882.1; Bottazzi, F. 1907.1; Gage, S. H. 1905.2; Schöndorff, B. & Wachholder, K. 1914.1; Bernard, C. Add. 1879.1; Brammertz, W. Add. 1914.1.

Chlorine, variations according to medium, in Cobitis. Calugareanu, D. 1910.1,.2.

Iodine content of thyroids. Cameron, A. T. 1913.1, Add. 1914.1.

Absence of glycogen and sugar in electrical organs of Torpedo. Dubois, R. 1899.1.

Analysis of the urine in various fishes. Buijtendijk, F. J. 1909.1; Davy, J. 1857.2; Dekhuyzen, M. C. 1904.2; ★Denis, W. 1912.1, Add. 1913.1; Heinroth, O. 1895.2; Jones, J. 1856.1; Ubaldini, G. 1871.1.

Composition of pathological calculi, chiefly intestinal. Delachanel, B. & Mermet, A. 1874.1; Fourcroy, A. & Vauquelin, L. 1807.1; Harting, P. 1875.2. —*Biliary calculi in squeteague.* Tower, R. W. 1902.1.

Ichthylepidin in fish scales. Green, E. H. & Tower, R. W. 1902.1,.2; Mörner, C. T. 1898.1, 1902.1.

Red color of salmon flesh due to lipochrome pigment related to tetron or zoonerythrin. Newbigin, M. I. 1900.1. — *Review of this.* Prince, E. E. 1916.2.

Bile of fishes, composition. Otto, R. 1867.1; Scherer, J. 1857.1; Schlossberger, J. 1858.1; Zanetti, C. U. 1902.1.

Crystalline lens, composition. Payen, A. 1857.1; Valenciennes, A. & Fremy, E. 1854.3.

Mucous secretions of the skin of the hagfish Myrine, composition. Reid, E. W. 1893.1, 1894.1.

Percentage of water in brain of dogfish. Scott, G. G. 1912.1, 1914.1.

Nitrogen distribution in liver of Acipenser. Wakeman, A. J. 1905.1.

Scyllite from spleen of sharks. Müller, J. Add. 1907.1.

Composition of cartilage in sharks and rays. Bunge, G. 1899.1; Chevreul, M. E. 1811.1,.2; Harting, P. 1873.2; Lönnberg, J. 1884.1; Marchand, R. F. 1836.1; Soxleth, F. & Petersen, P. 1873.1.

Composition of subdermal connective tissue of Mola. Green, E. H. 1901.1.

Fat or adipose tissue. *Metabolism, etc. Studies on the fat and fat-cells of fishes: composition, histology, etc.* Giles, A. E. 1890.1; Mottram, V. H. 1912.1; Nemiloff, A. 1906.1; Rosenfeld, G. 1912.1; Weill, J. 1914.1; Zdarek, E. 1902.1; Zuntz, N. 1903.1; Leeuwenhoek, A. Pre-Linn. 1724.1.

Fat-storage in muscles of the salmon: metabolism, absorption during migrations, etc. Greene, C. W. 1912.1–.6; Mahalanobis, S. C. 1898.1.

Fat content of Selachian liver: its role *during pregnancy, etc.* Bottazzi, F. 1907.1; Polimanti, O. 1912.6, 1913.4; Reach, F. 1912.1.

Amount of fat in different fishes, in relation to their comestible value. Payen, A. 1834.1–1865.1; Fage, L. & Legendre, R. Add. 1914.1; Hughes, F. Add. 1891.1.

Analysis of fish flesh

Changes in flesh of herring during reproductive period. Milroy, T. H. 1908.1.

Characteristic odor of sea-fish flesh. Panzer, T. 1910.1.

Fluorine in tissue. Gautier, A. & Clausmann, P. 1913.1. — *Urea in shark flesh.* Krukenberg, C. F. 1888.1. · — *Sulphur content of flesh.* Schulz, H. 1893.1. — *Nitrogen content of dried codfish.* Yoshimura, K. & Kanai, M. 1913.1.

Chemical analyses of the flesh of fishes, chiefly from the viewpoint of the relative percentages of proteids, fat, carbohydrates, ash, water, waste, etc. Almen, A. 1877.1; Balland, M. 1898.1; Calderwood, W. L. 1904.4; Chittenden, R. H. 1877.1; Christison, R. 1872.1; Frédéricq, L. 1901.1, 1905.1; Kensington, E. T. 1884.1; Lebedintsev, A. A. 1905.2; Morin, B. 1822.1; Payen, A. 1834.1–1865.1; Payen, A. & Wood, - 1854.1; Stirling, W. 1885.1; White, G. F. & Thomas, A. 1914.1; Weidenbusch, H. 1847.1; Zuntz, N. 1903.1; König, J. & Splittgerber, A. Add. 1909.1.

For additional references of a similar nature, see Nutritive value *below* Economic products *under* Fisheries.

For the chemical composition of young eels under various conditions of nutrition or starvation, see Reuss, H. & Weinland, E. 1912.1.

At many places in France, the transparent stages (*Leptocephali*) *of the eel are eaten under the names of "Civelles" and "Piballes." Their food value because of their fat content is relatively greater than other older stages, according to* Vaillant, L. L. 1903.3.

Extractive bodies. *In fishes, the nitrogenous extractives of the muscles (flesh) consist chiefly of creatine and creatinine.*

Various papers. Baglioni, S. 1906.3,.4; Krukenberg, C. F. 1881.1,.2, Add. 1881.2; Suwa, A. (*Trimethylaminoxyd*) 1909.1,.2; Suzuki, U., Mihata, M., Otsuki, S. & others 1912.1; Wilson, D. W. & Lyman, J. F. 1913.1; Buglia, G. & Costantino, A. Add. 1913.1; Okuda, Y. Add. 1912.1.

Discovery of nitrogenized protic acid in Cyprinid, Rutilus. Limpricht, H. 1863.1. — *Review of this.* Harting, P. 1863.2.

Isocreatinine in extractives. Discovered by Thesen, J. E. 1898.1. — *Considered an impure creatinine by* Poulsson, *and by* Schmidt & Korndörfer, *in* Arch. f. exp. Path. u. Pharm., vol. 51.

CIRCULATORY OR VASCULAR SYSTEM

Comprising the blood vascular system of fishes, including arterial, venous, and lymphatic systems.

Both Heart and Blood, essential parts of the vascular system, are treated separately because of the large number of citations under each.

For an authoritative, readable article on the vascular system, see the chapter in ★Bridge, T. W. 1904.1.

Origin and evolution of the circulatory system. Cahall, W. C. 1891.1; Lankester, E. R. 1873.3.

Anatomy and morphology. Miscellaneous papers. Harting, P. 1857.1; Hyrtl, C. J. 1844.1, Add. 1838.1; Sabatier, C. P. 1873.1; Sède de Liéoux, P. 1886.1. — *Relation of blood and lymph vessels to the "Saftkanälchen."* Arnold, J. 1875,1.

Anatomy of circulatory system in — *Amphioxus.* Legros, R. 1900.1, 1902.1; Martino, A. 1846.2; Možeyko, B. 1912.2, 1913.3,.5.

Cyclostomata. — *Ammocoetes.* ★Cori, C. J. 1906.1; Dohrn, F. A. 1882.2 (xiii); Julin, C. 1888.1. — *Petromyzon.* Favaro, G. 1905.1; Možeyko, B. 1910.1,.2, 1911.3, 1912.3–1912.5. — *Bdellostoma.* Jackson, C. M. 1901.1. — *Heptatrema.* Kirk, H. B. 1912.1.

In various fishes, chiefly Teleosts. — *Loricati.* ★Allen, W. F. 1905.1. — *Amphipnous.* Hyrtl, C. J. 1858.3. — *Amiurus.* Mackenzie, T. 1884.1. — *Lota.* Melnikov, N. 1866.1. — *Lepidosteus.* Mitchell, S. W. 1860.1. — *Mustelus.* Parker, T. J. 1886.1. — *Selachii.* Robin, C. P. 1845.2. — *Plectognaths.* Rosén, N. 1912.1 (i). — *Lopholatilus.* ★Silvester, C. F. 1904.1. — *Ceratodus.* Spencer, W. B. 1893.1. — *Monopterus.* Volz, W. 1905.1,.5, 1906.1.

Development and embryology. *For recent comprehensive general treatises on the development of the blood circulatory system see* ★Hochstetter, - Add. **1906.1** *and* ★Rückert, J. & Mollier, S. Add. **1906.1.**

Miscellaneous papers. Brigidi, V. & Tafani, A. 1878.1; Reichert, C. B. 1858.1.

Development of blood vessels in Cyclostomata. ★Hatta, S. 1908.1; Keiser, W. Add. 1914.1; ★Mollier, S. Add. 1906.2.

Development in Elasmobranchii. Hoffmann, C. K. 1893.2; ★Mayer, P. 1887.1, 1888.1, 1894.1; Raffaele, F. 1891.1; ★Rückert, J. 1888.1, 1906.1; Virchow, H. 1895.2, 1897.1, 1898.1; Thompson, A. Add. 1831.1. — *Torpedo.* Emmert, J. 1900.1. — *Acanthias.* Hoffmann, C. K. 1892.1. — *Yolk-sac circulation, development in Scyllium.* Hochstetter, F. 1905.1; Virchow, H. 1897.1. — *Sinus terminalis, Torpedo.* Rückert, J. Add. 1903.1.

Dipnoi and Ganoidei. Mollier, S. 1906.1, Add. 1906.2. — *Ceratodus.* ★Greil, A. 1908.1,.2, 1913.1; Kellicott, W. E. 1904.1, 1905.1. — *Lepidosiren.* ★Robertson, J. I. 1913.1. — *Lepidosteus.* Virchow, H. 1894.1.

Teleostei. Borcéa, J. 1909.1, 1910.1; Filippi, F. 1845.2; Grochmalicki, J. 1910.1; Mollier, S. 1906.2. — *Salmonidæ.* ★Sobotta, J. 1894.1, **1902.1**; Ziegenhagen, P. 1894.1, (*Belone*) 1896.1.

Vascular endothelium (*the epithelial cells lining the blood vessels and lymphatics*).

Circulatory Syst. — *Cont'd.*

Origin, development and structure — In branchial vessels. Biétrix, E. 1895.2,.3. — *Kupffer's cells of endothelium of liver.* Nathan, M. 1908.1. — *Of intestinal veins, Selachii.* Neuville, H. 1900.1. — *Development from mesenchymal cells.* ★Stockard, C. R. **1915.1,.2.**

Origin of cardiac endothelium. Nöldeke, B. 1899.1; Rückert, J. 1887.2, 1888.1.

Vascular system of various regions. *Dohrn's sinus in the tail region of Petromyzon.* Dohrn, A. 1882.2 (xiii); Možeyko, B. 1911.1,.2, 1912.5; Vogt, C. C. & Yung, E. 1888.1.

Retia mirabilia, networks of small blood vessels found in — Liver of Thynnus and intestinal wall of Alopecias. Eschricht, J. F. & Müller, J. 1835.1,.2. — *Spiral valve of sharks.* Duvernoy, G. L. 1833.1; Neuville, H. 1897.3, 1901.1. — *Spleen, Selachii.* Pouchet, G. 1882.1.

For other retia mirabilia, arterial or venous vascular networks, found in various organs, see under Air-bladder, Brain, *and* Eye (Choroid Gland).

For a general account of Retia mirabilia, the "Wundernetze," see Müller, J. 1840.4.

Lacunæ in branchial region. Biétrix, E. 1894.1, 1895.2,.3.

ARTERIAL SYSTEM

Anatomy in various fishes. — Lota. Bonsdorff, E. J. 1853.1. — *Selachii.* Carazzi, D. 1905.1; Cavalié, M. 1903.1. — *Raja.* Hyrtl, C. J. 1857.1, 1858.1. — *Myxine.* Cole, F. J. 1905.1 (iv). — *Polyodon.* Danforth, C. H. 1912.1. — *Acipenser.* Demme, R. 1860.1. — *Lepidosteus.* Hyrtl, C. J. 1851.1.

Aorta and aortic arches

Aorta, development in — Cyclostomata. Julin, C. 1887.3. — *Acanthias.* Hoffmann, C. K. Add. 1892.1.

Ligamentum longitudinale ventrale, a ligament lying in cavity of aorta and concerned with propulsion of blood. Burne, R. H. 1909.2. — *Development of this ligament from mesenchyme in contiguity with, but independently of, the hypochord.* Franz, K. 1897.1.

Aortic arches, structure. Boas, J. E. 1880.1; Locy, W. A. 1906.1. — *Saccobranchus.* Burne, R. H. 1894.1. — *Fifth aortic arch, causes of disappearance.* Kerr, J. G. 1908.3. — *Development of aortic arches.* Legros, R. 1903.1. — *Origin, Selachii.* Rückert, J. 1888.1.

Arteries supplying particular parts or regions

Axillary or innominate arteries. *Morphology. — Accessory arterial bulbs (Nebenherzen) of axillary arteries in Chimæra.* Duvernoy, G. L. 1837.1; Valentin, G. G. 1842.2. — *Morphology of axillary arteries, Selachii.* Pitzorno, M. 1905.1.

Branchial arteries. *Morphology in — Chimæra, Heptanchus, and Raja.* Allis, E. P. 1912.1,.2,.3. — *Squalus.* Home, E. 1813.1. — *Teleosts.* Biétrix, E. 1894.1; ★Maurer, F. 1888.1. — *Dipnoi.* Boas, J. E. 1880.1. — *Ganoids.* Hyrtl, C. J. 1852.1. — *Cyclostomes.* Julin, C. 1887.4. — *Acipenser.* Virchow, H. 1890.3.

Special researches on the branchial arteries. — Arrangement of capillaries in gills. Quekett, J. T. 1852.1. — *Relations of efferent branchial blood-vessels to the "circulus cephalicus" in teleostean fishes.* Ridewood, W. G. 1899.2.

Carotid arteries. *Anatomy and morphology. — General account.* ★Ayers, H. 1889.1.

Carotid arteries in Elasmobranchii. — Chlamydoselachus. Allis, E. P. 1911.1; Ayers, H. 1889.1. — *Chimæra, Heptanchus, and Raja.* Allis, E. P. 1912.1,.2,.3. — *Head of Selachii.* Hyrtl, C. J. 1872.1. — *Acanthias.* Beauregard, H. Add. 1892.1. — *External carotid, Oxyrhina.* Trois, E. F. 1879.1.

Morphology in Polypterus, Polyodon, Amia, and Ceratodus. Allis, E. P. 1908.2, 1911.2, 1912.4, 1914.4.

Morphology of carotid arteries in various Teleostei. ★Allis, E. P. 1908.1,.3, 1912.4.

Development of carotid arteries in Cyclostomes. Julin, C. 1887.3.

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VENOUS SYSTEM

Anatomy and morphology

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Homologies of veins in Dipnoi. Parker, W. N. 1889.1.

Development *of venous system.* ★Hochstetter, F. 1887.1, 1893.1. — *In Selachii.* Hoffmann, C. K. 1893.3; Rabl, C. 1892.1. — *Carassius.* Wintrebert, P. 1908.1.

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Anatomy and morphology

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In various fishes, chiefly Teleosts. Hyrtl, C. J. 1843.1; Jossifov, M. S. 1905.1, 1906.1; Trois, E. F. 1867.3, 1878.1,.2. — *Amia.* Hopkins, G. S. 1893.1. — *Lophobranchii.* Huot, A. 1897.1. — *Gadus.* Jourdain, S. 1867.1. — *Gadidæ and Pleuronectidæ.* Trois, E. F. 1878.1. — *Muræna.* Jourdain, S. 1868.2. — *Lophius.* Trois, E. F. 1876.4, 1878.1. — *Uranoscopus.* Trois, E. F. 1878.1, 1880.4. — *Amiurus.* Kilborne, F. L. Add. 1885.1.

Development *of the lymphatic system.* Favaro, G. 1908.2; Lankester, E. R. 1873.3. — *Bdellostoma* (*tail region*). Allen, W. F. 1913.1. — *Trout.* ★McClure, C. F. 1913.1–1915.2, **1915.1.**

Special parts of lymphatic system

Lateral lymph vessels. Hyrtl, C. J. 1843.1; Robin, C. P. 1845.3,.5.

Lymph sinuses, structure and function. — *Peribranchial lymph spaces in Petromyzon.* Ewart, J. C. 1878.1. — *Cephalic sinus.* Hyrtl, C. J. 1843.1. — *Saccus paravertebralis, Teleosts.* Nusbaum, J. 1903.3.

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For general considerations of the caudal heart, see ★Favaro, G. 1905.2–1906.1.

Caudal heart of Cyclostomata. — *Bdellostoma.* Greene, C. W. 1900.1, 1902.1. — *Myxine.* Retzius, M. G. 1890.1.

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Lymphoid tissue. Called also " adenoid tissue " and represented by local masses or organs in various parts of the body. The " lymphatic glands " of higher vertebrates are lacking in fishes.

Histology of lymphoid tissue. Ciaccio, C. 1909.1; ★Drzewina, A. **1905.1.**

Lymphoid "glands" or organs — *In œsophagus of Selachii (Torpedo especially).* Drzewina, A. 1904.3, 1909.1, 1910.2; Kulchitzkiĭ, N. 1911.1. — *In heart of Acipenser.* Hertwig, C. W. 1873.1; Schultze, M. J. 1872.1. — *Heart of Mola.* Trois, E. F. & Perugia, A. 1867.1. — *Kidney, Polyodon.* Downey, H. 1909.1.

Lymphatics of the intestine. Davidoff, M. 1886.1. — *Torpedo.* Diamare, V. 1913.1; Vialleton, L. 1902.2. — *Teleosts.* Langer, C. 1870.1. — *Lota.* Melnikov, N. 1866.1, 1867.1. — *Elasmobranchii.* Pilliet, A. H. 1890.1. — *Development.* Stöhr, P. A. 1897.1.

Lymphatics of the nervous system. — *Lymphoid structure above brain of Lepidosteus.* Chandler, A. C. 1911.1. — *In spinal meninges.* Sterzi, G. 1901.1. — *Central nervous system Selachii.* ★Sterzi, G. 1907.1.

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PHYSIOLOGY

Circulation of blood and lymph

Miscellaneous and general papers. ★Brünings, W. 1899.1; Gruetzner, P. F. 1897.1, 1899.1, 1901.1, 1904.1; Le Sauvage, E. 1821.1; ★Schoenlein, K. 1895.1; Schoenlein, K. & Willem, V. 1895.1,.2. — *Early refs.* Duverney, J. Pre-Linn. 1729.1; Leeuwenhoek, A. Pre-Linn. 1695.1–1709.2.

Special researches in the physiology of the circulation. — Distribution of blood in gills, sharks and teleosts. Biétrix, E. 1894.1; Döllinger, I. 1837.1. — *Caudal circulation in various fishes.* Favaro, G. 1905.5. — *Hypobranchial circulation in Elasmobranchs.* Ferguson, J. S. 1911.1. — *Systemic, portal, and caudal heart circulation in Bdellostoma.* Greene, C. W. 1900.1, 1902.1.

Circulation in capillary vessels. Hall, M. 1831.1. — *Circulation in suprarenals.* Srdinko, O. V. 1905.1.

Lymph circulation in Pleuronectes. Jourdain, S. 1880.2; Pouchet, G. 1881.1.

Blood pressure. — *In heart.* Biétrix, E. 1894.2. — *Relation to functional activity.* Greene, C. W. 1905.1. — *Effects of intravenous salt solutions on blood pressure in Skate.* Hyde, I. H. 1908.1, 1909.1. — *Blood pressure in branchial artery.* Jolyet, F. 1872.1.

COLLECTION, PRESERVATION, AND EXHIBITION OF FISHES

For ways of securing specimens, of which many are applicable to the collector's needs, *see* Fishing methods.

For preservation of fishes for use as food, *see* Preservation, *under* Fisheries.

For a related topic, *see* Technique and methods of scientific investigation.

Museum curators in many parts of the world have issued circulars or leaflets containing instructions on the best methods of securing and preserving fishes as scientific specimens.

For the latest and most comprehensive work, see "★Handbook of instructions for collectors," issued by the British Museum (Natural History) London, 4th ed. 1921.

Directions and instructions *for the collection and preservation of fishes.*

Text in English. Agassiz, J. L. 1853.2; Bean, T. H. 1881.3; Günther, A. C. 1875.1; Jordan, D. S. 1902.6; Sinel, J. 1906.2; Anon. 291; Sclater, P. L. Add. 1862.1.

Text in French. Pellegrin, J. 1907.3, 1908.2; Turgot, E. F. 1758.1.

Text in German. Frenzel, F. 1892.1; Günther, A. C. 1875.2; Surbeck, G. 1910.6.

Text in various languages. — Russian. Berg, L. S. & Kouznetzoff, I. D. 1908.1. — *Spanish.* Delfin, F. T. 1900.1. — *Portuguese.* Goeldi, E. A. 1896.2. — *Japanese.* Tsuchida, T. Add. 1914.1.

Methods of collecting in South America. Haseman, J. D. & Eigenmann, C. H. 1911.1.

Appearance of color in alcoholic fishes. Bliss, R. 1872.1,.3; Cope, E. D. 1872.18.

Medium for preserving colours. Haly, A. Add. 1892.1; Guyot, – & Pajot, – Pre-Linn. 1749.1.

Miscellaneous papers, chiefly concerning preservation. Bonnet, C. 1774.1; Collins, J. W. 1881.1; Hemmen, – 1777.1; Innes, W. T. 1912.1; Leonhardt, E. E. 1905.20, 1908.3; Malm, A. H. 1882.1; Reifschneider, O. 1909.1; Ricord, A. 1827.1; Rusticus in Urbe 1829.1; Anon. 453, 456; Réaumur, R. A. Pre-Linn. 1750.1. — *Importance of killing freshly-captured fish.* Baird, S. F. 1871.23. — *Recognition of fishes caught by use of chlorine.* Rusconi, A. 1910.1.

Exhibition of fishes. *Museum exhibition, chiefly outlines and plans for educational exhibits.* Gray, J. E. 1841.1; Holder, C. F. 1908.5; ★Lucas, F. A. 1910.1; Meek, S. E. 1902.1; ★Miner, R. W. 1910.1.

For exhibits of fishes in particular institutions, see under Museums; *for displays with especial reference to fisheries, see* Exhibitions *under* Fisheries.

Taxidermy. *Methods in the mounting of fishes.* ★Figgins, J. D. 1910.1; Fox, Charles, 1839.1; ★Franklin, D. 1908.1; Shufeldt, R. W. 1894.3; Walker, C. A. 1870.1; Swainson, W. Add. 1840.1, 1870.1. — *Denton Brothers' method.* Bean, B. A. 1892.6. — *Davidson's method.* Davidson, H. E. 1885.1.

Metalloplastic process for the exhibition of fishes. Mattes, M. R. 1883.1.

How to make and color casts. Taylor, J. E. 1878.1.

Dried preparations. Dubois, R. Add. 1914.1; Gronovius, J. Pre-Linn. 1742.1.

COLORATION

For Color perception *in fishes, see under* Behavior.

For nature of the silvery substance of the fish skin, *see* Argenteum *under* Integument.

Coloration of various fishes. *Special papers dealing with the coloration of — Haplochilus.* Arnold, J. P. 1911.12; Gerlach, G. 1912.1. — *Bermuda fishes.* Bristol, C. L. 1903.2. — *Platypœcilus maculatus.* Finck, M. C. 1911.8. — *Florida fishes.* Fowler, H. W. 1903.1. — *Pœcilia limantouri.* Fowler, H. W. 1903.5. — *Electrical fishes.* Fritsch, G. T. 1901.1. — *Gibbonsia.* Holder, C. F. 1899.2. — *Phoxinus lævis.* Leydig, F. 1892.1. — *Marine fishes.* McIntosh, W. C. 1901.1. — *Variations in Etheostoma caprodes.* Moenkhaus, W. J. 1893.1–1894.1. — *Deep-sea fishes.* Nutting, C. C. 1899.1. — *Cremnobates and Pomacentrus.* Smith, R. 1883.2,.4. — *The aɣon.* Weber, M. C. 1907.1. — *Xiphophorus rachovii.* Weinhausen, H. 1911.1. — *Fistularia tabacaria.* Wright, T. S. 1863.1.

Coloration of various young fishes. — Cyprinidæ. Agassiz, J. L. 1848.2. —

Leuciscus. Ayres, W. O. 1848.1, 1849.3. — *Labrus* (*coloration of pelvic fins*). McIntosh, W. C. 1887.1. — *Gadus*. McIntosh, W. C. 1910.1. — *Pomacanthus*. Nichols, J. T. 1915.4.

Chromatophores. *Histological structure and arrangement, relation to other epidermal cells, circulatory system, etc.* Franz, V. 1908.2; Garstang, W. 1895.1; Nègre, L. 1906.1; Pouchet, G. 1875.1; Rabl. H. 1897.1; Zimmermann, K. W. 1893.1; Golovin, E. Add. 1907.1; Lehmann, A. Add. 1906.1; Solger, B. F. Add. 1890.1. — *Pigment cells of intestine*. Oppel, A. 1889.1. — *Division in peritoneum*. Roques, E. G. 1904.1.

Origin and development of color-cells. ★Asvadourova, N. 1913.1; Bolk, L. 1908.1–1910.1; Borcéa, J. 1909.3; Cavalié, M. 1904.1; Eigenmann, C. H. 1891.3, Add. 1889.1; Eigenmann & Eigenmann 1889.6; Ryder, J. A. 1886.10; ★Stockard, C. R. 1915.1,.2; Wagner, K. 1911.1.

For the mechanism of contraction and expansion producing changes in coloration, see below.

Influence of food, light, and temperature. — *Food*. Knauthe, K. 1894.1. — *Effects of starvation*. Sécerov, S. 1909.1, 1910.1, 1912.1 — 1914.1.

Red variant of Perca fluviatilis, coloration due to crustaceorubin from food. Mäklin, F. W. 1864.1; Mela, A. J. 1881.1, 1902.1; Palmén, J. A. 1886.1; Schneider, G. 1908.3; Sjöstedt, G. 1894.1; Suomalainen, F. W. 1908.2.

Light, influence on coloration. Murisier, P. 1912.1; Regnard, P. 1893.1; Steinach, E. Add. 1891.1. — *Reflection from mirror produces pigmentation of colorless, ventral side of flounder*. ★Cunningham, J. T. 1891.3, 1893.10, 1895.1; Cunningham & MacMunn, 1893.1. — *Influence on pigmentation of Crenilabrus*. ★Gamble, F. W. Add. 1909.1, 1910.1. — *Effect of darkness on goldfish*. Ogneff, J. F. 1908.1, 1910.1, 1911.1; Viré, A. 1904.1.

Temperature, influence. Frisch, K. 1911.3. — *Warmth*. Murisier, P. 1912.1. — *Cold*. Polimanti, O. 1912.2.

Nuptial coloration. *General*. Barrett-Hamilton, G. 1902.1; Hess, C. 1913.1; Kornhuber, G. A. 1900.1. — *Coregonus*. Bean, B. A. 1895.2. — *Of Anguilla*. Petersen, C. G. 1895.4, 1896.1.

See also Breeding Habits, *and* Spawning Habits, *under* Reproduction. *See also under* Sexual dimorphism.

Pigments, nature or chemical composition. ★Ballowitz, E. 1912.1–1914.1; ★Cunningham, J. T. & MacMunn, C. **1893.1**; Krukenberg, C. F. 1882.1.

Blue coloring matter, nature. Leydig, F. 1885.1; Pouchet, G. 1872.1,.7, 1873.1. — *In Duymaeria*. Hilgendorf, F. M. 1879.1. — *In fins of Crenilabrus pavo*. Zeynack, R. 1901.1, 1912.1,.2.

Blue-green pigment of Odax, composition. Francis, G. Add. 1875.1. — *Green pigment of Belone*. Krukenberg, C. F. Add. 1882.2.

Protective coloration and mimicry. *Miscellaneous papers on protective coloration*. Lagally, M. 1903.1; Laloy, L. 1907.1; Prince, E. E. 1892.1; Smith, W. A. 1893.1. — *Popular acc't*. Ward, F. 1908.2. — *Reflection as a concealing and revealing factor*. Ward, F. 1913.1.

Brilliant (non-concealing) coloration of coral-reef fishes considered an " immunity " coloration, all " warning " coloration considered likewise. ★Reighard, J. E. 1908.1; Longley, W. H. Add. 1913.1, 1914.1.

Mimicry in fishes. Bézier, T. 1902.1; Bouvier, E. L. 1888.1; Dunn, M. 1896.1; Moenkhaus, W. J. 1895.2; Anon. 360. — *Possible mimicry of poison-spined weever fish (Trachinus) by the common sole (Solea).* Masterman, A. T. 1908.2. — *Ophichthys colubrinus mimicking the snake, Platurus colubrinus.* Schnee, S. 1905.1.

Mimicry of a leaf by Monocirrhus polyacanthus. Milewski, A. 1914.2,.8.

For further data on this fish, see C. H. Eigenmann & W. R. Allen, "A leaf mimicking fish." Biol. Bull. 1921, vol. 41, pp. 301–305. 3 figs.

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Mimicry of environment in Pterophryne. Ives, J. E. Add. 1899.1.

Miscellanea. *Notes, remarks and minor papers on coloration.* Aflalo, F. G. 1903.1; Bean, B. A. & Weed, A. C. 1911.2; Bliss, R. 1872.3; Camerano, L. 1885.1; Eigenmann, C. H. 1890.2; Fowler, H. W. 1912.4; Garman, S. 1877.3; Goode, G. B. 1890.1, Add. 1889.1; Heincke, F. 1875.1; Jäger, Gustav 1868.1, 1908.2; Jordan, D. S. 1902.1; Kapelikin, V. 1904.1; Leonhardt, E. E. 1904.9; Lönnberg, A. J. 1902.4, 1903.3; Nichols, J. T. 1916.7; Putnam, F. W. 1859.1; Smith, W. A. 1897.1; Wied-Neuwied, M. A. 1853.1; Adams, A. Add. 1848.1; Cuénot, L. Add. 1892.1.

Relation to vertical distribution in Cyclogasteridæ. Burke, C. V. 1911.1. — *Unilateral coloration with a bilateral effect, in Leptocephali.* Eigenmann, C. & Kennedy, C. 1901.1. — *Selection and coloration.* Popoff, M. 1906.1. — *The markings of fish with relation to their ancestral origin.* Kent, W. S. Add. 1892.1.

Biological significance of silvery coloration or lustre. Abonyi, S. 1908.1; Franz, V. 1907.2; Kapelikin, V. 1905.1; Murisier, P. 1915.1; Schnee, S. 1908.1; ★Hess, C. Add. 1914.1.

ABNORMALITIES IN COLORATION

Albinism or lack of pigmentation. *Miscellaneous*. Bézier, T. 1902.1; Goode, G. B. 1875.1,.2; Schreitmüller, W. 1911.12; Seabra, A. F. 1909.1.

Records of occurrence of albinism or partial albinism in — *Tinca vulgaris* (*partial*). Bellotti, C. 1906.1. — *Rhombus*. Boeke, J. 1904.1. — *Acipenser*. Brandt, J. F. 1850.1; Brunn, M. 1901.1. — *Pleuro-*

Coloration — *Cont'd.*

nectes platessa. Cunningham, J. T. (*piebald spm.*) 1893.1; Gadeau de Kerville, H. 1895.1; Schleep, B. C. 1829.2. — *Myxine* (*partial*). Dean, B. 1903.2. — *Brook-trout.* Freeburg, B. 1878.1; Pettis, C. R. 1903.1. — *Merluccius.* Garstang, W. 1900.1. — *Anguilla.* Knox, F. J. 1871.1; Raettig, A. 1879.1; Seligo, A. 1901.2. — *Solea.* Lagatu, H. 1887.1; Sacchi, M. 1899.1,.2. — *Clarias anguillaris.* Panceri, P. 1873.1. — *Micropterus.* Shufeldt, R. W. 1902.14. — *Salmo fario.* Surbeck, G. 1904.1. — *Raja.* Traquair, R. H. 1893.8. — *Silurus.* Zur Mühlen, M. 1911.24.

Ambicoloration or unicoloration in flat-fishes, *see under* Pleuronectidæ.

Melanism or development of black pigmentation. ★Klunzinger, C. B. 1903.2, 1907.1; Knauthe, K. 1892.1. — *Barbus.* Annandale, N. 1907.2. — *Cyprinodon.* Arnold, J. P. 1912.30. — *Phoxinus lævis.* Fatio, V. 1875.1,.2. — *Platyglossus.* Günther, A. 1871.1. — *Cyprinidæ.* Siebold, C. T. 1861.2.

Metachromatism or abnormal color variants, *suggesting albinism, xanthochroism, etc.* — *Polychromism in Myxine.* Dean, B. 1903.2. — *In various Italian fishes.* Ninni, E. 1903.3 (*Pleuronectes*), 1907.2, 1908.1; Trois, E. F. 1909.2, (*Lophius*) 1909.3. — *Anguilla.* Ninni, E. 1912.2; Pavesi, P. 1894.1; Trois, E. F. 1905.2, 1908.3.

Xanthochroism, or appearance of yellow pigmentation. Schreitmüller, W. 1911.12. — *Anguilla.* Bolau, C. C. 1881.2; Kershaw, J. A. 1904.1. — *Petromyzon.* Festa, E. 1900.1. — *Nemachilus.* Fischer, J. 1874.1. — *Phoxinus.* Riedel, K. 1911.1.

CHANGES IN COLORATION

Adaptive coloration or slight temporary modifications in coloration to fit the environment. Agassiz, A. 1892.1; Franz, V. 1910.2; La Blanchère, P. R. 1872.4; Noé, J. & Dissard, A. 1894.1; Schenk, H. 1914.1.

Observations on color changes in various fishes. Heincke, F. 1875.1; Schreitmüller, W. 1914.7; Semper, C. Add. 1895.1. — *Salmo fario.* Crisp, E. 1864.1; Schöndorff, A. 1903.1. — *Cottus bubalis.* Cunningham, J. T. 1889.2. — *Gasterosteus.* Dallas, J. 1895.1. — *Capros aper.* Day, F. 1880.9. — *Labrus maculatus.* Holt, E. W. & Byrne, L. W. 1897.2. — *Lebias.* Schenk, H. 1914.1. — *Echeneis.* Schnee, S. 1902.1; Vaillant, L. L. Add. 1884.1.

Miscellaneous papers on changes in coloration. Chamberlain, W. B. 1867.1; H., T. W. 1876.1; Harting, P. 1868.3, 1871.3; Hermann, L. 1896.1; Kent, W. S. 1873.3; M., A. R. 1871.1; Regan, C. T. 1909.9; Schenkling-Prévôt, – 1894.1; ★Townsend, C. H. 1908.1, 1910.1; Anon. 131, 203, 204.

Experimentally induced changes. Pouchet, G. 1871.2, 1872.7, 1873.1. — *Importance of physical stimulus.* Rynberk, G. A. 1911.1,.2. — *Slow changes through confinement in vessels of different colors.* Stark, James 1830.1. — *Nocturnal and diurnal changes.* Verrill, A. E. 1897.1. — *Seasonal changes.* Wheatland, R. H. 1862.1.

Influence of vision (including color perception) in color changes. (*Watson considers such adaptation to background as an instinctive response, controlled entirely by the sympathetic system and without reference to color perception.*)

Adaptation in coloration of flat-fishes (*Pleuronectidæ*) *to various backgrounds, and influence of vision in these changes.* Bordage, E. 1911.1; Loeb, J. 1912.1; Mast, S. O. 1915.1,.2, Add. 1913.1; Polimanti, O. 1912.1; ★Sumner, F. B. 1910.1–**1911.2**; Steinach, E. Add. 1891.1. — *Coloration of flounders after extirpation of eyes.* Buijtendijk, F. J. 1911.1; Lubach, D. 1864.2.

Popular review of Sumner. Montanus, E. 1912.1.

For a most valuable contribution with colored plates on color changes in the flounders, see ★Mast, S. O. *in* Bull. U. S. Bureau Fisheries, 1914 (1916), vol. xxxiv, pp. 173–238, 19 pls.

Unilateral change, produced by excision of one eye. Pouchet, G. 1877.1,.2; 1879.1. — *Discussion of this work.* Giard, A. 1877.1. — *Visual influence.* Fiore, G. 1906.1.

Lack of color adaptation in blinded fishes. Mayerhofer, F. 1909.1; Pouchet, G. 1876.1; Sumner, F. B. 1911.2.

For other instances of color vision, involving only slight color changes, see Color perception *under* Behavior.

Mechanism of color changes *through contraction and expansion of chromatophores.* Ballowitz, E. 1912.1–1914.1, Add. 1914.1–.3; Lode, A. 1891.1; Nardo, G. D. 1844.3; Pfeffer, G. J. 1910.1; Provazek, F. 1900.2; ★Spaeth, R. A. 1913.1–1914.1; Vescovi, P. 1886.1; Zimmermann, – 1893.1; Fuchs, R. F. Add. 1914.1; ★Rynberk, G. A. Add. **1906.1.**

Innervation of chromatophores, relation to central nervous system, etc. Bauer, V. 1910.2; Eberth, C. J. & Bunge, R. 1895.1; Frisch, K. 1910.1; ★Pouchet, G. 1871.1, 1872.3, **1876.1;** Rynberk, G. A. 1906.2, 1907.1, 1908.1; Ballowitz, E. Add. 1893.1, 1894.1. — *Effects of section of nervus sympathicus.* Sécerov, S. 1913.1.

COMMENSALISM AND SYMBIOSIS

For a related topic, *see* Parasitic fishes. *See also* Parasites of fishes.

Popular general works, including fishes. Beneden, P. J. Add. 1876.1; Step, E. Add. 1914.1.

Miscellanea, popular accounts, etc. Beneden, P. J. 1869.1, 1871.1; Christopher, H. 1905.1; Coupin, H. 1899.1; Cuénot, L. 1892.1; Grieg, J. A. 1896.3. — *Barnacle on gar pike.* Ryder, J. A. 1879.2. — *Mullet encased in Pyrosoma, an Ascidian.* Giglioli, E. H. Add. 1886.1.

Algæ and fishes. *Green algæ growing on fishes.* Link, E. 1911.1; Minakata, K. 1908.1.

For plants destructive to fishes such as the bladderwort, see Noxious organisms *under* Pisciculture. *For* Fungus growths, *see* Diseases of the gills and skin *under* Pathology.

Coelenterates and fishes. *Hydroids and fishes.* Franz, V. & Stechow, E. 1908.1; Heath, H. 1910.1; Lloyd, R. E. 1907.2,.4. — *Minous inermis and hydroid, Stylactis.* Alcock, A. W. 1892.1, 1899.4. — *Dogfish with Sertularia on dorsal spine.* Cornish, T. 1868.5. — *Hippocampus covered with Serialia.* Newman, E. 1873.2.

Fishes associated with medusæ. Alcock, A. W. 1901.1; Gadeau de Kerville, H. 1894.1; Gill, T. N. 1877.5; Oesterbol, A. 1885.1,.2; Peach, C. W. 1855.1; Scheuring, L. 1915.1; Collingwood, C. Add. 1867.1, 1868.1. — *Caranx and medusæ.* Lunel, G. 1883.1; Pellegrin, J. 1905.3; Anon. 64; Giard, A. Add. 1887.1. — *Trachurus and medusæ.* Macleay, W. J. Add. 1884.2.

Fishes (Premnas and Amphiprion) living in sea anemones. Collingwood, C. 1868.1; Crespigny, C. C. 1869.1; Horst, R. 1901.1; Sluiter, C. P. Add. 1888.1.

Nomeus commensal with the Portuguese Man-of-war (Physalia). Wallich, G. C. Add. 1863.1, 1869.1.

Echinoderms and fishes. *Syngnathus intestinalis living inside Holothurians.* Ramsay, E. P. 1881.1. — *Fish (not named) commensal with an echinus.* Sarasin, C. F. Add. 1886.1.

Fierasfer symbiotic with echinoderms, pearl oysters, and tunicates. *Fierasfer living in Holothurians.* Alcock, A. W. 1901.1; Anderson, A. J. 1859.1; Bosset, C. P. 1839.1; ★Emery, C. **1880.1, .2**; Grieg, J. A. 1896.3; Holder, C. F. 1881.1; Holder, J. B. 1871.1; ★Linton, E. 1907.1; Waite, E. R. 1897.1; Semper, C. Add. 1868.1.

Living in starfishes. Bleeker, P. 1854.17, .19, 1858.14; Doleschall, C. L. 1858.1–1861.2.

Symbiosis with pearl oysters. Günther, A. 1886.1; Parville, H. 1899.1; Putnam, F. W. 1874.4; Saint-Amans, J. F. 1778.1; Southwell, T. 1910.3; Stearns, R. E. Add. 1887.1.

Living within tunicates. Weber, M. 1905.1.

Mollusks and fishes. *Apogonichthys strombi (a fish) living in the mantle cavity of Strombus gigas.* Plate, L. H. 1908.1.

Occasionally fishes (Fierasfer and Oligocottus) have been found, imbedded or covered over by the mother-of-pearl layer, in valves of the pearl-oyster. See Günther, A. 1886.1; *and* Stearns, R. E. Add. 1887.1.

The following citations indicate that occasionally fishes (Batrachus and Ophidium) may be found in oysters. Dekay, J. E. 1842.2; Heyke, D. Pre-Linn. 1744.1.

For incubation (of Bitterling, Rhodeus) in gill-cavities of mussels, see Parental care *under* Reproduction.

For implantation and parasitism of the Glochidia of fresh-water mussels (Unionidæ) on fishes, see Mollusca *under* Parasites.

Sponge and fish. *Garmannia spongicola n. sp. from off North Carolina, a goby inhabiting the cavities of large cuplike sponges.* Radcliffe, L. 1917.1.

Symbiosis among fishes

The pilot fish (Naucrates ductor) accompanying sharks. Beneden, P. J. 1870.1; Geoffroy-Saint-Hilaire, E. 1802.7, 1807.2; Holder, C. F. 1900.2; Moseley, H. N. 1879.1; Penny, C. F. 1873.1; Winkler, - 1802.1; Anon. 362.

Seriola zonata accompanying sharks. Holder, C. F. 1900.2.

The sucking fishes, Echeneis *and* Remora, *symbiotic with sharks.* Baird, S. F. 1876.16; Beneden, P. J. 1870.1; Burnell, A. H. 1876.1; Castillo, L. 1912.11; Cornish, T. 1870.3; Geare, R. I. 1902.1; Holder, C. F. 1900.2, 1905.2; Moseley, H. N. 1879.1; Anon. 362.

Echeneis symbiotic with — Sphyræna barracuda. Lütken, C. F. 1874.1 (v). — *Balistidæ.* Murphy, R. C. 1914.1.

For a discussion of the habit of the sucking fishes of entering the gill cavities or mouths of their hosts, with a résumé of all known accounts, see E. W. Gudger *in* Natural History, 1922, vol. 22, pp. 243–249.

DEEP-SEA FISHES

Under this term are included the fishes adapted to conditions of extreme cold and utter darkness living between the 100-fathoms line or the boundary of the continental shelf, often taken as an arbitrary upper limit, and the abyssal depths of nearly 3¾ miles.

The latter, the greatest from which a deep-sea fish has been dredged, is the profound depth of 6,035 meters, (19,800 ft.) where, off the Cape Verde Islands, a Brotulid, *Grimaldichthys profundissimus* Roule (1913.5, Add. 1914.2) was taken by the Prince of Monaco.

A table including the recorded depths for all (earlier) species will be found in Brauer, A. 1908.1, pp. 365–410.

Macrias amissus from off southern Chili, largest deep-sea fish recorded to 1900, was about five feet in length. Gill, T. N. & Townsend, C. H. 1901.1.

Apparatus used in deep-sea investigations. Regnard, P. 1893.4; ★Tanner, Z. L. 1885.1–1889.1; Add. 1897.1; Townsend, C. H. 1902.1, Add. 1896.1; Albert I, H. C. Add. 1891.1; Hoyle, W. E. Add. 1889.1.

Existence of a pelagic element in the bassalian fauna. Chun, C. 1887.1, 1888.1, 1890.1.

"*Tenanting of the deep sea with fishes has been a gradual process, beginning at latest in early Cretaceous times and gradually proceeding until the present day.*" Woodward, A. S. 1898.1.

Miscellaneous items, popular accounts, etc., on deep-sea fishes. Agassiz, A. 1888.1; Carpenter, W. L. 1870.1; Christison, S.

Deep-sea Fishes — *Cont'd.*
1905.1; Delaroche, F. E. 1809.3; Evermann, B. W. 1902.24; Goode, G. B. 1889.1; Hussakof, L. 1915.2; Jordan, D. S. 1908.1; Malmgren, A. J. 1870.2; Martens, J. B. 1883.1; Vaillant, L. L. 1886.1, 1887.1; Wade, H. T. 1910.1; Anon. 228, 393; Gill, T. N. Add. 1884.1; Hunt, A. R. Add. 1888.1.

General popular treatises

The following citations are general popular scientific works on the conditions affecting life in the depths of the ocean, including some matter on fishes. Many of these authors have been leaders in deep-sea and general oceanographical investigations.

Text in English. Bullen, F. T. 1901.1–1904.2; Hickson, S. J. 1893.1; ★Johnstone, J. 1908.1, 1911.2; ★Murray, J. & Hjort, J. **1912.1**; ★Thomson, C. W. 1873.1, **1877.1**; Wallich, G. C. 1862.1.

Text in French. Dollo. L, 1885.1, Add. 1891.1; ★Filhol, H. 1884.1, **1885.1.**

Text in German. ★Chun, C. 1900.1, **1903.1**; Marshall, W. A. 1888.1; Seelinger, O. 1901.1.

The following are smaller papers on the environmental conditions prevailing in the oceanic depths. Mangoldt, E. 1912.1; Nutting, C. C. 1901.1; Reed, T. S. 1904.1; Roule, L. 1912.6; Walther, J. K. 1904.1.

General systematic treatises

For a recent valuable systematic monograph with colored plates of many characteristic species and a full bibliography, based primarily on the collections of the " Valdivia " of the German Deep-Sea Expedition, see ★Brauer, A. **1908.1.**

For a general résumé, with descriptions and figures of all forms known up to 1895, based chiefly on the collections of the "Albatross," see ★Goode, G. B. & Bean, T. H. **1896.1.**

Large collections were obtained which have been made the subjects of extensive monographs, in the reports of the following oceanographic expeditions. — *" Investigator," Indian Ocean.* Alcock, A. W. 1899.1. — *" Challenger."* ★Günther, A. **1887.5.** — *" Travailleur et Talisman."* ★Vaillant, L. **1888.2.**

The collections of the Prince of Monaco, made principally in the North Atlantic and the Mediterranean on the campaigns of his yachts, " Hirondelle " and the "Princesse Alice," have been described by Albert I, H. C. 1887.1–1906.1; Collett, R. 1889.1, 1890.1, 1896.2; Richard, J. 1905.1; Roule, L. 1913.5, 1914.1,.6; ★Zugmayer, E. 1911.1, **1911.2**, 1913.2, 1914.1.

List of known species of deep-sea fishes, with distribution. Garman, S. 1899.1.

Coloration of deep-sea fishes

The significance of coloration in deep-sea fishes is intimately bound up with the question of the depth of the penetration of sunlight. Many authors, especially Nutting, believe that light in the greater depths is furnished by the phosphorescent organisms.

Dr. J. Hjort of the " Michael Sars " expedition (Hjort, J. 1911.1), found that at 500 meters red rays are absent and blue and violet rays present; at 1,000 m. ultra-violet rays are perceptible; and at 1,700 m. there is no trace of light. He suggested that the 500 meter line marks the border between two differently colored faunas; iridescent and silvery fishes occur in the upper zone, black and red fishes in the lower. At and beyond such depths these colors would tend to render the fishes invisible.

For further discussion of the coloration of deep-sea fishes, see Burke, C. V. 1911.1; Nutting, C. C. 1899.1, 1901.1.

Sense organs of deep-sea fishes

For the anatomy of the phosphorescent organs, see under Luminosity and phosphorescence.

For the most comprehensive treatment of the anatomy of the eye and the phosphorescent organs of deep-sea fishes, see ★Brauer, A. **1908.2.**

Structure of the eyes, both normal and the protruding telescopic eyes of some forms. Brauer, A. 1902.2,.3, 1904.1; Caullery, M. 1905.1; Franz, V. 1907.1; Frisch, K. 1909.1; Lendenfeld, R. 1885.1; Zugmayer, E. 1910.2.

Possibility of vision in the deep sea. Chun, C. 1893.1.

Anatomy of the — brain. ★Trojan, E. 1906.1 — *of the ear.* ★Bierbaum, G. Add. 1914.1.

DEEP-SEA FAUNA

With a geographical arrangement

Antarctic Ocean. ★Dollo, L. 1900.1–1900.4, **1904.1**, 1906.2,.3, 1907.1, 1908.1, 1909.1,.3; ★Pappenheim, P. 1914.1.

Arctic Ocean. Jensen, A. S. 1905.1; Jordan, D. S. & Clark, G. A. 1906.1; Lütken, C. F. 1880.1,.4. — *Bering Sea.* Gilbert, C. H. 1895.1.

Indian Ocean. ★Alcock, A. W. 1889.3–1902.1; Alcock, A. W. & McGilchrist, A. C. 1892.1; Boulenger, G. A. 1901.17; ★Lloyd, R. E. 1909.1.

North Atlantic Ocean

Various localities, especially deep waters off the European countries. Bean, B. A. 1898.2; Bean, B. A. & Weed, A. C. 1909.1,.2; Beechey, F. W. 1842.1; Collett, R. 1904.1; ★Goode, G. B. & Bean, T. H. 1878.2,.4,.5, 1881.2, 1882.3, 1885.2, .3, 1894.1,.2,.3; Günther, A. C. 1874.4, 1888.2, 1889.1,.2,.3; ★Hjort, J. 1901.4, 1911.1,.2; Holt, E. W. & Byrne, L. W. 1908.1; Jungersen, H. F. 1898.1, 1899.1, 1905.1; Lea, E. 1913.2; Poppe, S. A. 1903.1.

Deep water off Portugal. Girard, A. A. 1893.2, 1895.1; Lütken, C. F. 1894.1; Neuville, H. 1897.2; Osorio, B. 1906.2, 1909.1, 1911.1; Wright, E. P. 1868.1.

Mediterranean Sea. Ariola, V. 1904.1, 1912.1; Giglioli, E. H. 1884.1, 1893.1; ★Lo Bianco, S. 1901.1, **1903.1,** 1904.1; Marion, A. F. 1883.2; Palacky, J. 1887.1; ★Zugmayer, E. **1911.2.**

Pacific Ocean

Off Japan. Jordan, D. S. 1898.2; Jordan, D. S. & Snyder, J. O. 1903.1; ★Jordan, D. S. & Starks, E. C. 1904.1 (*List*); Tanaka, S. 1910.1.

Southern Pacific. Gilbert, C. H. 1908.1, 1911.1. — *Hawaiian Is.* ★Gilbert, C. H. 1905.1. — *Off Tasmania.* McCulloch, A. R. 1907.1. — *Off New Zealand.* Hamilton, A. Add. 1896.1.

DENTITION (*OF FISHES*)

Comprising the development, histology, and morphology of the teeth of fishes.

For related subjects, *see* Integument, *and* Dermal Skeleton.

General treatises

Works of a general nature, chiefly comparative odontologies or manuals of the dentition of all vertebrates, including chapters on fishes.

Text in English. ★Owen, R. 1840.1; Wortman, J. L. 1886.1; ★Tomes, C. S. Add. **1914.1.**

Text in German. Baume, R. 1882.1; Giebel, C. G. 1855.1; ★Terra, P. Add. **1911.1.**

An excellent short non-technical account in English on the teeth of fishes, is ★Ridewood, W. G. 1896.2.

Probably the most scholarly treatises in German are those cited under ★Röse, C. 1892.1–**1896.1**, 1897.1.

Miscellaneous topics

Homology of hair with teeth of shark. Brandt, A. T. 1898.2.

Origin of perforations in teeth of a fossil Carcharodon. Burrows, H. A. 1876.1.

Suppression and specialization of teeth. Humphreys, J. 1889.1.

Fishes' teeth contrasted with those of other classes. Menhuir, W. H. 1902.1.

Nerve terminations in teeth of Teleostei. Retzius, M. G. 1892.9.

Structure and anchorage in vertebrates. Struck, W. 1915.1; Watson, G. W. 1900.1.

Origin of teeth

The identity in development and structure of the placoid dermal elements (shagreen denticles) with the teeth, in Elasmobranchs, was recognized in Williamson, W. C. 1849.1, *and elaborated in* ★Hertwig, O. 1874.1.

During the inpushing of the outer skin in the formation of the stomodæum, these placoid elements (teeth) have been carried into the oral cavity. While teeth are generally restricted to supporting bones or cartilages, in numerous species of sharks and rays, practically unmodified placoid scales persist in the lining of the oral cavity and pharynx.

For references, see Imms, A. D. 1905.1; Spengel, J. W. 1905.1; ★Steinhard, O. 1903.1.

Similar oral and pharyngeal denticles in Chimæroids are figured in Dean, B. 1906.1, p. 121.

The formation of a triconodont tooth (in Chlamydoselachus), through the fusion of three separate simple teeth, is shown in ★Röse, C. 1894.2.

Histology of teeth

Histological structure and development of teeth. Born, G. 1827.1; Fischer von Waldheim, G. 1801.1; Heincke, F. 1873.1; Hilgendorf, F. M. 1888.1; Morgenstern, M. 1909.1; Owen, R. 1839.4, 1840.3; ★Röse, C. 1897.1; Schwalbe, G. A. 1894.1; Waldeyer, H. W. 1864.1; Huxley, T. H. Add. 1853.1; Owen, R. Add. 1839.1.

ENAMEL

As early as 1848, M'Coy (Sir F. 1848.1, p. 124) following the then recognized fact that the enamel of fishes differs in development from that of mammals, applied the term "ganoine" to the layer of "false enamel" on the teeth of certain fossil sharks (Chomatodus). As pointed out to him by Prof. Owen (Owen, R. 1849.1) the latter's term "vitrodentine" had previously been in use. About the same time, Williamson (W. C. 1849.1, p. 438) independently, but more aptly, used the term "ganoin" for the enamel-like substance of the scales of Lepidosteus.

While the exact nature of enamel seems not yet entirely settled, a recent authority (Tomes, C. S. 1900.1, p. 62) retains the term "enamel" which he divides into the following types.

(1) Enamels *not* wholly *epiblastic* in origin. The stroma which is the seat of enamel calcification is furnished by a transformation of the exterior of the *mesoblastic* dentine papilla, the ameloblasts apparently segregating the lime salts required for its hardening. (This type is found in Elasmobranchs and is unquestionably a modified dentine — vitrodentine of Owen.)

(2) Enamels wholly *epiblastic* in origin, in which the ameloblasts undergo a prior transformation into a stroma of the dimensions of the finished enamel and themselves disappear. This type is met with in the Gadidæ, in Sargus and in Labrus and probably other fishes.

(3 and 4) The other types, also epiblastic in origin but in which the ameloblasts persist, are confined to the mammals.

For papers specifically relating to development and structure of enamel, see Nunn, E. 1883.1, *and* ★Tomes, C. S. 1898.1–1900.1.

DENTINE

Although accurately described as early as 1836 by Retzius (A. J. 1836.1), the various forms of dentine were not named until the appearance of the "Odontography" of Owen (Owen, R. 1840.1) whose terms are now generally accepted.

As more precisely defined by Tomes (C. S. 1878.2), the forms now recognized are (1) hard unvascular dentine, (2) vaso-dentine, (3) plicidentine (Labyrinthodon, not in fishes), and (4) osteo-dentine.

Structure and development of dentine. Korff, K. 1910.1; ★Mummery, J. H. 1893.1; Studnička, F. K. 1906.2, 1909.2; Sternfeld, B. Add. 1882.1; ★Tomes, C. S. 1878.2.

Cornified epithelial teeth of Cyclostomata

In this group the teeth are purely cuticular, formed by an axial dermal papilla, invested by epidermis and an external horny cone. They are without genetical relations to the teeth in other groups.

In *Myxine* and *Bdellostoma*, according to Beard, the dermal papilla develops an imperfectly calcified tooth beneath the epidermal cornification.

Dentition — *Cont'd.*

Development, structure, and arrangement of teeth in various genera, chiefly Petromyzon. Beard, J. 1888.7, 1889.1; Behrens, G. 1891.1; ★Jacoby, M. 1894.1; Renaut, J. 1900.1; Scott, W. B. 1883.2; Tims, H. W. 1906.1; ★Warren, E. 1902.1; Studnička, F. K. Add. 1900.1.

Dentition of Plagiostomi

Numerous genera of fossil sharks, whose relationships, in many cases, are but imperfectly known, have been described from isolated teeth. It is obviously beyond the sphere of the present work to adequately refer to these genera. They are, moreover, carefully treated in Woodward's "Catalogue of the fossil fishes in the British Museum" (Woodward, A. S. 1889.2), to which reference may be made.

There are a large number of Pre-Linnæan references to isolated fossil shark teeth, which were known as glossopetræ, and to the fossil teeth of pycnodont fishes known as bufonites (toad-stones, *i. e.*, stones supposed to have been formed in the head of a toad). These are brought together *under* Palæontology.

The myth of the toad-stones is discussed in Hussakof, L. 1915.3.

Important treatises in German, chiefly inaugural dissertations, on the development and histological structure of Selachian teeth. Benda, C. 1881.1; ★Hertwig, W. A. 1874.1; ★Jentsch, B. 1897.1; ★Laaser, P. 1900.1, 1903.1; Owen, R. 1839.3, 1840.4; ★Röse, C. 1897.1; Treuenfels, P. 1896.1.

Numerous shark teeth were dredged in the tropical Pacific by the Albatross. See Eastman, C. R. 1903.6, 1906.3.

Histology and development of the rostral teeth of the sawfish, Pristis. ★Engel, H. 1909.1; Green, J. 1859.2; Hilgendorf, F. M. 1888.1; Kölliker, R. 1860.5.

Peculiar modified flattened posterior teeth occur in the Port Jackson shark, Cestracion. Miklukho-Maklai, N. N. 1879.1.

Dentition of the eagle rays, Myliobatidæ. These possess both an upper and lower median series of modified, flat, pavement-like, crushing teeth. ★Gudger, E. W. 1910.2, 1914.1; Harless, E. 1847.1; ★Stefano, G. **1914.2**; Stromer, E. 1904.1; Treuenfels, P. 1896.1.

Sexual differences chiefly in the shape and size of the teeth have been described in the following forms. — *Raja.* Lütken, C. F. 1874.3,.5. — *Notidanus* (*Heptanchus*). Macdonald, J. D. & Barron, C. 1868.1. — *Mobula.* Pellegrin, J. 1912.12.

The evolution of sharks' teeth. Woodward, A. S. 1892.4.

Fine figures of the teeth and of the jaws with teeth of Plagiostomes may be found in Garman, S. 1913.1.

Descriptions of individual teeth or the complete dentition of the following forms. — *Carcharias.* Ayres, W. O. 1849.5. — *Rhineodon.* Bean, B. A. 1905.2; Gudger, E. W. 1915.1. — *Hexanchus.* Carruccio, A. 1896.1. — *Notidanus primigenius.* Probst, J. 1858.1. — *Chlamydoselachus.* Röse, C. 1894.2. — *Mustelus.* Spengel, J. W. 1905.1. — *Lamna.* Stannius, F. H. 1842.1. — *Cetorhinus.* Turner, W. 1879.2.

Dentition of various fossil Elasmobranchs. — *Cladodus.* Claypole, E. W. 1895.6; Eastman, C. R. 1900.1. — *Acanthodei.* Dean, B. 1907.2. — *Cochliodontidæ.* McCoy, F. 1852.1; Owen, R. 1867.3,.4.

Miscellaneous and usually unimportant papers on sharks' teeth or the dentition, succession, etc. Agassiz, J. L. 1844.5, 1874.2; André, W. 1784.1; Balkwill, F. H. 1875.1; Bicknell, E. 1872.1; Cocco, L. 1896.1; Forbes, H. O. 1879.1; Grube, A. E. 1878.2; Waldow, - 1911.1.

Miscellaneous early references to sharks' teeth, to be found in Pre-Linn. *section.* Geoffroy, C. 1741.1; Hérissant, F. 1753.1; Lister, M. 1674.1.

Dentition of Holocephali

The dental plate of Chimæroids (Callorhynchus) develops from a single enlarged flattened tooth according to Schauinsland, H. H. 1903.1 (p. 13, pl. 20).

General remarks on Chimæroid dentition. Hilgendorf, F. M. 1886.1.

Dental plates of Jurassic Chimæroids. Jaekel, O. M. 1901.1.

Dentition of Dipnoi

Homology with Dinichthys. Gill, T. N. 1879.4.

Teeth; Upper Silurian forms. Rohon, J. V. 1899.1.

In Neoceratodus, as shown by Semon, the dental plates arise by the fusion of a number of separate small teeth. Briquel, M. P. 1898.1; ★Semon, R. W. 1899.2, 1901.5.

Dental plates of numerous fossil species of Ceratodus. Böklen, H. 1887.1; Miall, L. C. 1878.1,.3; Woodward, A. S. 1907.1.

Histology of teeth of Protopterus. Owen, R. 1840.2; Röse, C. 1892.1.

Dentition of Lepidosirenidæ. Stromer, E. 1910.2.

Dentition of Teleostomi

Development and histology of teeth in Teleostei. Carlsson, A. 1894.1; ★Friedmann, E. 1897.1; Ghigi, A. 1905.1,.2; Röse, C. 1897.1; Tomes, C. S. 1875.1–1900.1.

CHONDROSTEI and HOLOSTEI

The Acipenseridæ, according to Zograf, possess teeth while young. From the sterlet (*Acipenser ruthenus*), in which they are lost at the age of one year, a series extends to *Psephurus gladius* which retains them throughout life. *Polydon* likewise retains its teeth when mature.

References. Murray, A. 1871.1; Parker, W. K. 1881.1 (pl. 14, fig. 6); Pavlov, H. 1879.1; Peltzam, E. 1870.1; ★Zograf, N. Y. 1887.5, 1896.2.

Lepidosteidæ. Barkas, W. J. 1878.2. — *Lepidosteus, analogies with labyrinthodonts.* Wyman, J. 1844.1.

TEETH OF TELEOSTEI

Most systematic treatises include descriptions of the form and arrangement of the teeth. Numerous genera are based on such characters.

It is thus obviously out of question to attempt to give a complete list of references here. The following citations are to separate papers dealing with the dentition of the forms named.

Anarrhichas and Chætodon. André, W. 1784.1. — *Scaridæ.* ★Boas, J. E. 1879.2. — *Orthagoriscus.* Hilgendorf, F. M. 1893.1. — *Salmonidæ.* Knox, R. 1855.1. — *Echeneis.* Mummery, J. H. 1899.1; Murray, A. 1856.1. — *Gymnodontes.* Owen, R. 1839.4, 1840.3. — *Piabuca.* Rowntree, W. S. 1906.1. — *Cyclopterus.* ★Schmidt, B. 1913.1. — *Esox.* Tomes, C. S. 1878.1. — *Mugil.* Troschel, F. H. 1865.1. — *Loricariidæ.* Weyenbergh, H. 1875.2. — *Anarrhichas.* Wilson, A. 1879.1,.2. — *Labrus.* Wright, J. 1870.1. — *Hydrocyon.* Eastman, C. R. Add. 1917.1.

Although Coregonus wartmanni is toothless when adult, true rudimentary teeth occur in embryos of 1 cm. Walter, H. E. 1894.1.

Pharyngeal teeth of Teleostei

In certain Teleosts occur clusters of grinding teeth (pharyngeal teeth) capable of replacement by vertical succession.

The lower pharyngeals are usually composed of the paired ceratobranchial elements of the last (fifth) branchial arch which is reduced on each side to this element.

In the Cyprinidæ these grind against a callous pad above on the basi-occipital.

In the Labridæ they are opposed above by the upper pharyngeal teeth formed on the pharyngobranchials of the posterior branchial arches.

For an excellent series, with photographs, of the pharyngeal teeth of many different species, see ★Shepherd, C. E. **1913.1.**

Pharyngeal teeth of Cyprinidæ. Čerkasov, P. G. 1903.1; Fack, – 1897.1; ★ Gracianov, V. I. 1900.1; ★Hæmpel, O. 1907.2, 1908.2,.3; Hoppe, R. 1894.1; Jurine, L. 1821.2; Leonhardt, E. E. 1903.10; Molin, R. 1850.1; Nordmann, A. 1863.2.

Variability of pharyngeal teeth in Cyprinoid hybrids. Heincke, F. 1892.1.

Pharyngeal teeth of other fishes. — *Scaridæ.* Boas, J. E. 1879.2. — *Labridæ, development.* Prince, E. E. 1893.1. — *Orestias.* Pellegrin, J. 1904.12. — *Gerridæ.* Sauvage, H. E. 1876.4. — *Labrus.* Wright, J. 1870.1.

Comparison of pharyngeals of Labrus from Italian Tertiary with those of recent Mediterranean species. Brunati, R. 1909.1.

Isolated fossil or sub-fossil pharyngeal teeth were earlier known as "Serpent's eyes." See Jussieu, A. Pre-Linn. 1725.1.

DERMAL SKELETON (*OF FISHES*)

Comprising the morphology of the Exoskeleton, the Dermal Denticles, and the Scales.

The dermal fin-rays (dermotrichia), which constitute a part of the exoskeleton, are treated *under* Fins.

The dermal skeleton should properly include the " dermal " or " membrane bones," but these are necessarily treated *under* Skull.

Scales are usually included under the general term " integument." In the present work, however, *under* Integument, will be found references merely to the soft structures of the epidermis and the dermis.

Introductory

In the Cyclostomata the skin is soft and entirely lacking in hard structures such as denticles or scales. There is thus no suggestion of a dermal skeleton in this group.

In the Elasmobranchs, however, true " placoid " *denticles* are present. These, more fully described below, consist of separate hollow cones of dentine capped by " enamel." Each separate denticle, with growth, develops a more or less expanded basal portion, the " basal plate." In these fishes, true bone never develops.

In the higher bony-fishes (Teleostomes) and in the Dipnoi the true *scales* occur. These develop, usually as oval flattened structures, in pockets within the dermis and are at no time contributed to by the epidermis. They grow throughout life by the deposition of successive layers of bony substance.

Agassiz (J. L. 1833.2) divided fishes into the four groups, Placoidei, Ganoidei, Cycloidei, and Ctenoidei, based on the characters of their scales. That this arrangement was untenable, especially for the higher groups, was soon shown by the experience of one of his students, Prof. N. S. Shaler (Atlantic Monthly, Feb., 1909, p. 222), who discovered that one species of Pleuronectidæ " had cycloid scales on one side and ctenoid on the other." Likewise Peters (W. C. H. 1841.1) soon showed that the bonito (Sarda) possesses both cycloid and ctenoid scales. Agassiz (1850.6) decided that the scales of the bonito were intermediate and sometime later (1857.2) he definitely renounced his classification as being too artificial.

Except among palæontologists, where often the scales of certain fossil forms constitute the only remains preserved, the scales have not been much studied as an aid in the classification of fishes.

More recently Cockerell (T. D. 1909.4–1914.1) has assiduously studied and described the minute structure of the scales of many species in all groups, especially the Teleostomes, with the idea of defining the distinctive characters which may aid in the determination or identification of the species. The taxonomic value of " lepidology " has however not since been extended.

Principal literature

Modern views on the morphology and development of scales had their inception in the works cited under ★Williamson, W. C. 1849.1, *and* 1851.1.

The most comprehensive treatises in German, on the morphology of dermal (placoid) denticles and scales are ★Hertwig, O. **1876.1**; *and* ★Klaatsch, H. **1890.1.**

By far the most illuminative memoir (in English) on the development, structure, and phylogeny of denticles and scales is ★Goodrich, E. S. **1908.1.**

Most of the previous views on the development and formation of scales are reviewed in English in ★Thomson, J. S. **1904.1.**

As stated above, Cockerell (T. D. 1909.4–1914.1, Add. 1914.1) *has described the superficial characters of the scales of many genera and species of fishes. See especially* ★Cockerell, T. D. 1911.5 *and* **1913.1.**

Miscellaneous papers

Mechanical considerations of the evolution, or causes of the arrangement and shape of scales. Ryder, J. A. 1892.1; Woodward, A. S. 1893.5.

Older or miscellaneous and unimportant papers on the structure and manner of growth of the scales of fishes. Agassiz, J. L. 1840.2,.3,.4; Alessandrini, A. 1849.1;

Dermal Skeleton — *Cont'd.*

Baster, J. 1762.2,.3; Benecke, B. 1882.1; Broussonet, P. M. 1787.1; Couch, J. 1868.2; Delsman, H. C. 1913.2; Hennah, T. H. 1873.1; Keene, J. H. 1879.2; Kuntzmann, J. H. 1829.1; ★Mandl, L. 1839.1–1840.1; Peters, W. C. 1841.1; Salbey, R. 1868.1–1870.1; Schmula, – 1854.1; Steeg, G. 1857.1, 1861.1; Swaine, L. H. 1870.1; Anon. 173, 526, 599; Engström, A. Add. 1874.1; Huxley, T. H. Add. 1855.1.

The chief points in many of these older papers are reviewed in Baudelot, E. 1873.4; *and in* Thomson, J. S. 1904.1.

The scales of fishes were among the first objects examined by the early microscopists. The following references, partly referring to such observations, will be found in the Pre-Linn. *section.* Fabricius d'Aquapendente, J. 1618.1–1625.1; Hooke, R. 1665.1; Leeuwenhoek, A. 1686.1–1719.2.

EVOLUTION OF THE PROTECTIVE COVERING

Phylogeny of scales

Williamson (W. C. 1849.1, p. 466) attempted to outline the derivation of the Teleostome scale from the denticle of the Elasmobranch. He believed that by the fusion of the basal plates of a number of adjacent denticles a large composite denticle was formed. By the successive depression or insinking of this composite denticle (ultimately to entirely within the dermis), by the obliteration or disappearance of the separate tips of the denticles (aggregated to form the " cosmine " layer), and by the acquisition of a basal film of true bone which subsequently overlaps the outer surface, the true scale has been formed.

These views, with modifications, have been adopted by Hertwig, (O. 1876.1), by Wiedersheim (R. E. 1880.4), and by others. Klaatsch (H. 1890.1) believed that each scale represents a single denticle of which the basal plate has become greatly enlarged.

According to Goodrich (E. S. 1908.1), the views of Williamson are not without difficulties, the chief of which is the lack of intermediate stages between the denticle and the Cosmoid scale. While in general adhering to Williamson's views, Goodrich considers the elements of the dermal skeleton to be divisible into two distinct forms as follows:

(1) The dermal *denticle* of Elasmobranchs, of which the " basal plate " is simply the expanded lower portion of the external cone.

(2) The *scale* of Teleostomi-Dipnoi, divisible into Cosmine and Ganoid types. The essential part of the scale is the development in the dermis of a *bony plate*. The overlying denticles may have subsequently become fused to this plate and by aggregation or fusion may have become reduced to the cosmine layer. While the denticles have generally become lost since the appearance of scales, in certain forms (Lepidosteus, Polypterus and some Siluroids), minute denticles persist and become secondarily attached to the scales and to the dermal fin rays (lepidotrichia).

DENTICLES

The so-called Placoid Scale of the Elasmobranchii

" True denticles are universally present in the living Elasmobranchs and their extinct allies.

" The placoid scale, or denticle, begins as a cone of dentine deposited by mesoblastic scleroblastic cells below the epidermis, in continuity with the basement membrane; a basal plate may be present in the form of a direct extension inwards of the cone, never as a separate element which becomes fused on to it secondarily; both the cone and the plate are composed of dentine or some allied substance, never of true bone; the cone may pierce the epidermis, when fully grown." Goodrich (1908.1, p. 753).

The outer surface of the denticle is covered with a hard, enamel-like layer of which the exact nature has been much disputed. As has been stated elsewhere (see Dentition), the identity of the teeth and denticles (" dermal teeth ") in Elasmobranchs has long been recognized. Röse (C. 1897.1) considered the enamel-like layer of the denticles and teeth to be a layer of dentine (vitrodentine). The arguments for and against its being enamel are summarized by Scupin (H. 1896.1). Although recognizing the primary part played by the mesoblastic dentine papilla in its formation, instead of its being wholly an epidermal secretion as is the true enamel of higher vertebrates, Tomes (C. S. 1898.1, p. 460) believes that this layer may be appropriately called *enamel*. It is not a dentine because there is no collagen matrix. For additional remarks on " Enamel," see under Dentition.

As pointed out by Steenstrup (J. J. 1861.2, .3), although probably incorrectly denied by Nardo (G. D. 1861.1), the denticles do not persist throughout the life of the shark and constantly increase in size as do the scales, but are shed individually to make place for others. They are subsequently replaced by the growth of newly developed denticles between the old ones.

Plagiostomi

Papers relating to the development, structure, and histology of the denticles or "placoid scales" of sharks and rays. Benda, C. 1881.1; Brackel, G. 1858.1; Green, J. 1859.2; Hannover, A. 1868.1; ★Hertwig, O. **1874.1**; ★Klaatsch, H. 1890.1; ★Kwietniewski, C. 1905.1; Meyer, P. 1886.1; ★Burckhardt, C. R. Add. 1902.1.

For excellent figures of the denticles of certain sharks and rays, see Garman, S. 1913.1, *and* Radcliffe, L. 1916.1.

The exoskeleton of Heterodontus francisci. Daniel, J. F. Add. 1914.1.

Holocephali

In the existing Chimæroids the skin is generally smooth but a few denticles are retained in rows along the head and back of young specimens. These are distinctly shark-like.

In addition, the males of all recent Chimæroids possess denticles, quoting from Dean (B. 1906.1, p. 117), " on the frontal clasping organ, on the mixipterygium, and on the anterior pelvic clasping organ. These denticles have a transparent almost glassy character. In the frontal clasping organ of Callorhynchus, they occur not only at the tip of the organ itself, but also proximalward and at the front and sides of the depression into which this clasping organ fits; but in the other genera, the denticles are limited only to the tip of this organ."

For a full discussion of the denticles in both recent and fossil members of this group, see ★Dean, B. 1906.1, pp. 114–118.

In Chimæra and Hydrolagus, Cockerell records oval horseshoe-shaped denticles, which line and serve to keep open a mucous canal, lying below the dorsal denticles. Cockerell, T. D. 1913.3.

Certain fossil Chimæroids, Squaloraja and Myriacanthus, possess an enlarged frontal spine or tentaculum, evidently a frontal clasper, probably derived from denticles. Davies, W. 1872.1; Reis, O. M. 1895.2; Woodward, A. S. 1906.3.

Dermal plates of the Ostracodermi

Concerning the exoskeleton of this early problematical group, we can do no better than quote from Goodrich (1908.1, p. 754), with necessary adaptations in reference numbers.

"The important researches of Traquair (R. H. 1899.2,.3) have disclosed a most interesting series of Palæozoic fish in which it appears to be possible to trace clearly the evolution of the bony carapace of the Pteraspids from the simple placoid scales of *Thelodus*. The latter are broad and flattened denticles. . . . Rohon (J. V. 1889.2, 1893.1) and Röse (C. 1897.1) have described their finer structure. The pulp cavity is simple and there is no distinctly marked basal plate. . . . *Psammosteus* is almost entirely covered with large plates (Traquair, R. H. 1899.3). Superficially these are studded with small denticles in every way similar to those of *Thelodus*. . . . Below these denticles is a thick plate of bone-like tissue, which, however, is devoid of bone cells.

"The denticles . . . rest on the underlying plate, to which they become fixed, being fused to it here and there at their base. . . .

"It is but a step from *Psammosteus* to *Pteraspis*, whose exoskeleton has been well described by Huxley (T. H. 1858.2) and Lankester (E. R. 1864.2, 1865.1). . . .

"Thus it appears that the shields of the Heterostraci, and also the scales and dermal fin-rays, have all been evolved by the combination of a covering of separate isolated denticles and an underlying plate, and the theory of Williamson is confirmed in a most remarkable manner by Traquair."

Professor Goodrich, having read proofs of this section, suggests:

"In the same way, within the *Osteostraci*, we can trace the development of a complete armour of scales and plates from primitive separate denticles which become fused on to underlying plates of true bone with bone cells."

THE TRUE SCALES

As stated above, Goodrich divides the scales previously known as "ganoid" into two types, the *cosmoid* of which the scale of Megalichthys (Osteolepidæ), well described by Williamson (W. C. 1849.1), is an example and the *ganoid* which is further divisible into two varieties.

A cosmoid scale grows only by the addition of new cosmine at the edge and of isopedine (bone) on the lower surface. No living fish has a cosmoid scale. Among extinct forms it occurs only in the extinct Crossopterygii and in the Dipteridæ.

The Ganoid scale

The "ganoid" scale, as restricted by Goodrich, is found in all recent "ganoids" (Goodrich's Actinopterygii). It does not occur in the Teleosts.

These scales are generally thick and rhomboid. They grow by the deposition of concentric layers over the whole surface, the oldest part of the scale being at the center. These layers on the lower surface are bony or fibrous; on the outer surface they are of the enamel-like substance called, in the case of Lepidosteus, *ganoin* by Williamson (W. C. 1849.1, p. 438). As shown by Hertwig and by Nickerson, the ganoin is entirely mesoblastic in origin and has no relation to enamel.

Goodrich (1908.1, p. 757) divides the ganoid scale into two distinct varieties, the "Palæoniscoid" type and the "Lepidosteoid" type. The latter is pierced by characteristic tubules, found also throughout the bony skeleton of living and fossil Amioidei and Lepidosteoidei (Goodrich, 1913.2).

Histological structure of "ganoid" scales in numerous fossil genera. Klaatsch, H. 1890.1; ★Scupin, H. 1896.1.

Structure of the scales in Polypterus. Hertwig, O. 1876.1; Leydig, F. 1854.1; Reissner, E. 1859.1; Scupin, H. 1896.1.

The presence of small scales in the integument of Polyodon is recorded in Collinge, W. E. 1895.1.

In Acipenser, the scales are relatively few, large plates composed of concentric layers of bone, entirely lacking the ganoin layer. Agassiz, J. L. 1856.1; ★Hertwig, O. 1876.1 (vol. ii); Kosmak, G. W. 1895.1.

Structure and development of the scales in Lepidosteus. Agassiz, J. L. 1856.1; Hertwig, O. 1876.1 (vol. v); ★Nickerson, W. S. 1893.1; Reissner, E. 1859.1.

In Amia the scales are thin and the ganoin vestigial. Unimportant references are Green, J. 1862.1; *and* Mackintosh, H. W. 1878.1.

Scales of Teleosts

The scales of Teleosts, although presenting great variations in form and structure, are in general thin and flexible and develop within dermal pouches. Their posterior edges usually slightly overlap the following scale.

Scales increase in size by the deposition of fine excentric rings entirely around the outer margin. These rings have been termed *growth-rings* (Zuwachsringe) and the fine lines limiting the growth rings are the *lines of growth* (Thomson, J. S. 1902.1).

During summer, with its favorable conditions for growth, the scale rapidly increases in size and the lines of growth are relatively far apart, but during the following winter, the growth-rings become fewer and narrower and the lines of growth consequently become crowded together. This variation produces a distinct appearance, the *annual ring* roughly comparable to the rings in many trees. These annual rings, as first demonstrated by Hoffbauer (C. 1898.1 *et seq.*), supply us with an index to the age of the fish.

The growth and annual rings have been much studied in recent years in connection with the determination of the age and growth of fishes. This constitutes a separate subject with an extensive literature, for which *see* "Recent methods in age determination" *under* Growth and age.

The scales grow continuously throughout life. If broken off or otherwise injured, they possess the power of regeneration (Mohr, E. 1914.1; Scott, W. 1911.1). Ryder (J. A. 1884.4) records that a carp, in which a scale had been detached, had, after five months, replaced the lost scale with one of the same size but thinner and also lighter in color. The condition of the growth-rings was not determined.

Cycloid and ctenoid scales

As indicated above (under Introductory remarks), the differences between cycloid and

Dermal Skeleton—*Cont'd.*

ctenoid scales, once thought fundamental, have been gradually shown to be unimportant. *Cycloid* scales may be defined as those which possess a smooth posterior margin; and *ctenoid*, those in which this margin is produced into a series of small spines. Reduced to the simplest terms, as shown by Cockerell & Moore (1910.2) and independently corroborated by Hase (A. 1911.1); when the growth-rings or circuli are parallel with the margin, the scale is cycloid. When, however, the growth-rings strike the posterior scale margin at a right angle or perpendicularly, their truncated ends form tooth-like spines and the scale is ctenoid. Each growth-ring may produce a spine or several may unite to form one spine (Hase).

Mandl (L. 1839.2), Vaillant (L. 1875.2) and Tims (H. W. 1905.1) erroneously believed the " teeth " of ctenoid scales to be homologous with the spines of the denticles of sharks. The correct view that they are merely projections of the posterior scale border, first propounded by Agassiz (L. 1840.3) in opposition to Mandl, has been held also by Baudelot, Carlet, Hofer, Klaatsch, and others.

Morphology of scales

Papers primarily on the development of scales, both cycloid and ctenoid, including their microscopic structure. ★Baudelot, E. 1873.4; Carlet, G. 1878.1, 1879.1; ★Grunelius, A. 1913.1; ★Hase, A. 1907.1; Hofer, B. 1889.1; ★Nusbaum, J. 1907.1; Rosén, N. 1915.1; Tims, H. W. 1905.1; Ussow, S. A. 1897.1.

Although the Characinidæ ordinarily possess cycloid scales, Gill enumerates four subfamilies with ctenoid scales. Gill, T. N. 1896.11.

Each scale of the lateral line is pierced by a pore of the lateral line canal. These references describe the lateral line scales in the following. —*Scopelidæ.* Cohn, L. 1907.2. —*Mugil.* Fée, F. 1869.1. —*Sciænidæ.* Sauvage, H. E. 1877.4. —*Serranidæ.* Vaillant, L. L. 1874.2.

Johnstone describes a flounder having part of the scales spinulated. Johnstone, J. 1904.1.

The Plectognathi including the Sclerodermi, containing the Trigger-fishes (Balistidæ), File-fishes (Monacanthidæ), Globe-fishes (Tetrodontidæ), and Porcupine fishes (Diodontidæ), have the body encased in heavy plate-like scales or, as in the Porcupine fish, Diodon, have the scales produced into sharp spines. Consult Dareste, C. 1850.2; Hertwig, O. 1876.1 (vol. vii); Hollard, H. L. 1853.1, 1860.1; ★Rosén, N. 1912.1 (iii); Kaschkaroff, D. N. Add. 1914.1.

The Trunk-fish (Ostracion) is encased in a rigid cuirass resulting from the union of rhomboidal plates placed side by side, which possess an inferior layer of a horny nature and a superior layer of osseous substance. Hollard, H. L. 1857.2.

The Lophobranchii, including the Pipe-fish (Syngnathus) and the Sea-Horse (Hippocampus), have the body protected by a series of dermal scutes forming rings. See Hoyer, H. 1901.1; Kasanzeff, W. 1906.1; *and* Schäff, E. A. 1886.1.

The John Dory (Zeus faber) possesses a series of bony plates or spines along the base of the median fins. For their number and arrangement, see Byrne, L. W. 1902.3.

The scales of Centriscus possess sharp spines and were thought to be intermediate between denticles and scales. Hertwig, O. 1876.1 (vol. vii, p. 15); Vaillant, L. L. 1888.1.

Separate papers have appeared describing the structure of the scales in the following forms. —*Cyclopterus.* ★Hase, A. 1911.2. —*Anguilla.* Jourdain, S. 1880.1. —*Zoarces.* Quekett, J. T. 1852.2. —*Gobius.* Vaillant, L. L. 1875.2. —*Chaunax.* Vaillant, L. L. 1888.1. —*Perca, Gobius, and Platessa.* Winther, G. P. 1872.1.

Scales of the American and Asiatic Cyprinidæ. Cockerell, T. D. & Allison, E. M. 1909.1; Cockerell & Callaway, O. 1909.1; Cockerell & Moore, E. V. 1910.1.

Scales of Dipnoi

In the recent lungfishes, the scales are cycloid and overlapping and sunk deep within the dermis.

References are Cockerell, T. D. 1911.7; Günther, A. (*Neoceratodus*) 1871.4; Klaatsch, H. 1890.1; Kölliker, R. A. (*Protopterus*) 1860.1; Wiedersheim, R. E. 1880.4.

Chemical composition of denticles and scales

The scales of Teleosts are composed chiefly of mineral matter, collagen, and ichthylepidin, the latter forming about one-fifth of the organic substance.

Ichthylepidin, which is close to elastin, was discovered by Mörner. It is insoluble in hot and cold water as well as in cold dilute acids or alkalies, but on boiling with the latter it dissolves. It responds to Millon's reagent and blackens, from loosely combined sulphur, when boiled with an alkaline solution of lead acetate.

Mörner found it to occur in the scales of twelve species of Teleosts examined but found it lacking in Lepidosteus. Green & Tower, examining the scales of thirty-five species of Teleosts belonging to widely separated families, found it to occur in all except the ocean sunfish (Mola) and the puffer (Spheroides). They found that it occurs in Acipenser.

The denticles of Elasmobranchs, however, have collagen as their organic basis. Four species of sharks and rays examined showed no trace of ichthylepidin.

Earlier papers on the composition of scales. Green, J. 1858.1–1862.1; Weiske, F. 1883.1; Wicke, W. 1853.1.

Jackson records the presence of fluorine in the scales of Lepidosteus. Jackson, C. T. 1856.2.

Nature and occurrence of ichthylepidin. Green, E. H. & Tower, R. W. 1902.1,.2; Mörner, C. T. 1898.1, 1902.1.

Economic uses of shark and other fish skins

Formerly pieces of sharks' skin with the attached hard denticles (shagreen) were used by cabinet makers for polishing wood and ivory. At present the production of other abrasives has largely resulted in their disuse. Such " shagreen " was very durable, a piece outwearing many sheets of sandpaper of equal area.

Similarly the dried or tanned skins of fishes have been used to some extent as ornamental leathers for covering small ornamental objects such as jewel boxes, card cases, knife and sword sheaths, etc.

These matters have been fully treated by C. H. Stevenson in " Utilization of the skins of aquatic animals," in Rept. U. S. Comm. Fisheries, 1902 (1904), part xxviii, pp. 281–352.

Vaillant (L. L. 1911.1) has recorded the use of the skin of the puffer (Tetrodon) for bags and other ornamental objects in Siam.

The natives of the South Sea Islands often wear helmets made of the skin, with the attached spiny scales, of the porcupine fish, Diodon. For references, *see* Hartzer, F. Add. 1900.1; Wilkes, C. Add. 1845.1; *and especially* E. W. Gudger *in* Bull. N. Y. Zool. Soc. 1919, vol. xxii, pp. 126–131.

DIGESTION IN FISHES

The basic literature on this subject is largely in German. For a complete résumé of the literature, consult ★Biedermann, W. Add. **1911.1.**

For a comprehensive treatise in French, consult ★Yung, E. J. Add. **1899.1.**

For works in English, consult Alcock, R. 1891.1, 1899.1; Stirling, W. 1884.1, Add. 1884.1; ★Sullivan, M. X. **1905.1;** Van Slyke, D. D. & White, G. F. 1910.1; Langley, J. N. & Sewall, H. Add. 1879.1.

Early work on digestion in fishes: Spallanzani placed tubes filled with flesh in the stomachs of fishes and noted digestion. Spallanzani, L. 1784.1.

Gastric juice argued to be alkaline, after mixture of stomach mucus with sublimate solution. Musgrave, W. Pre-Linn. 1684.1.

Enzymes, in addition to those treated below under Gastric, *and* Intestinal digestion. — *General topic.* ★Polimanti, O. 1912.7; Stirling, W. 1884.1, Add. 1884.1. — *Zymogen in spleen.* Boudouy, T. 1899.4. — *Enzymes in liver of Scyllium.* Buglia, G. & Constantino, A. 1913.1. — *Philothion, diastase of striated muscle.* Rey-Pailhade, J. 1912.1. — *Lipase in blood.* Sellier, J. 1902.2,.3. — *Arginase of intestinal digestion.* Clementi, A. Add. 1914.1.

Miscellaneous and unclassified papers on digestion. Brinton, W. 1862.1; Cajetan, J. 1883.1; Davy, J. 1860.1; Heynacher, – 1837.1; Kerb, H. 1910.1; Lipschütz, A. 1911.1,.2; Pancritius, P. 1887.1; Tangl, F. 1899.1; Thesen, J. E. 1890.1; Zuntz, N. 1898.1; Home, E. Add. 1807.1.

For the occurrence of pebbles in the stomachs of fishes, presumably aiding in the trituration of food, see under Gastroliths.

Gastric digestion. *Various papers on digestion in the stomach, changes in pepsin-forming glands, enzymes, etc.* Cattaneo, G. 1886.1,.3; Herter, E. 1891.1; ★Herwerden, M. A. 1908.1,.2; Richet, C. R. & Mourrut, – 1880.1; Yung, E. J. 1898.1, 1899.1; Langley, J. N. & Sewall, H. Add. 1879.1.

Investigations by means of glycerin extracts of gastric epithelium. ★Krukenberg, C. F. 1877.1, 1879.1, Add. 1881.2; Luchau, E. 1877.1, 1878.1.

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Numerous experiments made by the U. S. Bureau of Fisheries with fishes, to determine their availability in mosquito control, are detailed by ★S. F. Hildebrand (Rept. U. S. Comm. Fish. *for* 1918, Appendix IX, 15 p.), *and by* ★J. P. Moore (*ibid*, 1922, Appendix IV, 60 p.).

DISTRIBUTION OF FISHES

For references to all papers dealing with the fauna of a particular region, in many cases considering the problems of its origin and dispersal, *see* the particular region *under* Fauna of the world.

References to the distribution of particular fishes will be found under the various families and genera.

Geographical distribution

For an excellent summary of this subject, see ★Jordan, D. S. 1901.2, *substantially reprinted in his* 1905.1; *much information will also be found in* Meek, A. 1916.1.

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FRESH-WATER FAUNAS

Base-leveling and its faunal significance. Adams, C. C. 1901.1. —*Supposed identity of fishes of North America and Europe.* Gould, A. A. 1848.1. —*Relics of glacial period.* Menke, H. 1914.1.

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Possibility of dissemination of fishes by their eggs attached to aquatic birds or insects (considered probable). Paratre, R. 1894.1.

Possible former connection between Australia and New Guinea. Beaufort, L. F. 1910.1; Weber, M. C. 1907.3, 1908.1.

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Archiplata-Archhelenis theory for origin of South American fauna. Eigenmann, C. H. 1909.3.

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Discussion of Wallace's line in Oceanica. Regan, C. T. 1912.11.

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MARINE FAUNAS

Comparison, Atlantic faunas of Europe and America. Agassiz, J. L. 1858.3.

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Vertical distribution

For the dissolved gases as factors in determining vertical distribution in inland lakes, *see under* Ecology.

For all conditions determining bathymetric distribution in the depths of the ocean, *see under* Deep-sea fishes.

General account. Dambeck, K. 1875.1; *Mountain fauna of Sweden.* Ekman, S. 1907.1. —*Abyssal fauna of Lake Michigan.* Hoy, P. R. 1870.1. —*Fishes of Peruvian Andes.* Steindachner, F. 1876.3. —*Mountain fauna of Westphalia, Prussia.* Thienemann, A. 1912.1.

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Abyssal fauna of Swiss lakes. Asper, G. 1880.2; Du Plessis, G. 1885.1; ★Forel, F. A. 1872.1, 1874.2, 1885.1.

See also under Fauna, *for other lakes of high altitude, such as Titicaca Lake in South America.*

ECOLOGY

Comprising the ecological relations of fishes to their environment, types of habitats, etc.

For the association of fishes with hydroids, medusæ, etc.; *see under* Commensalism and symbiosis.

For marine fishes in freshwater and freshwater fishes in salt water, *see* Effects of changes in density and salinity *under* Physiology.

For upland or mountain-lake fauna, *see under* Distribution, vertical.

For the environmental conditions of certain ecological groups, *see under* such topics *as* Adaptation; Blind fishes of the caves; Deep-sea fishes; etc.

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For winter killing through lack of oxygen, etc., see under Mortality.

TYPES OF HABITATS

Fresh-water considered the habitat of the earliest vertebrates. Chamberlin, T. C. 1900.1; Pompečkj, J. F. 1914.1.

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Fishes in artesian wells in California. Chase, A. W. (*Trout*) 1874.1; Saxe, – 1870.1; Smith, R. (*Gasterosteus*) Add. 1884.1.

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Experiments on effects of curare, in Torpedo. Gotch, F. 1888.2; Moreau, F. A. 1860.1,.2; Schoenlein, K. 1895.3; Steiner, J. Add. 1875.1.

Development of nerves, *chiefly in Torpedo.* Ecker, A. 1849.1; Fritsch, G. T. 1892.1; Trinchese, S. 1892.1; Wagner, R. 1849.1.

Electrical center. *In spinal cord of Raiidæ.* Ewart, J. C. 1893.2; Dahlgren, U. Add. 1914.1.

Electrical center in Lobus electricus of medulla of Torpedo. Anatomy and histology. Fauré-Fremiet, E. & Mironesco, T. 1911.1; Fritsch, G. T. 1890.2; Harless, E. 1846.1; Hatai, S. 1901.1; Jonquière, G. 1879.1; Magini, B. 1894.1; ★Mencl, E. 1901.1, 1902.1, 1906.1, 1907.2; Paladino, G. 1909.1; Petelenz, J. 1886.1; Pighini, G. 1908.1; Reichenheim, M. 1873.1,.2, 1877.1; Rohon, J. V. 1878.1; Ramon y Cajal, S. 1888.1; ★Romano, A. 1899.1, 1902.2; Ruzicka, V. 1906.1; Solger, B. F. 1897.1,.2, 1902.1; Studnička, F. K. 1900.1. —*Nature of yellow color.* Romano, A. 1900.1. —*Perichromatin, a nuclear material.* 1902.1. —*Lobus electricus, development.* Schenk, S. L. 1877.1.

Nerve terminations in electrical organs. *Distribution, etc., chiefly in Torpedo.* A., C. 1858.1 (*Mormyridæ*); Ballowitz, E. 1898.3, 1899.2 (*Malopterurus*); Cavalié, M. 1904.4; ★Ciaccio, G. V. 1870.1, 1877.2,.3, 1883.1, Add. 1888.1; Crevatin, F. 1898.1; Ewald, A. 1881.1; Fritsch, G. T. 1893.1; Kölliker, R. A. 1856.1; ★Krause, W. 1886.1, 1891.1; Pighini, G. 1908.1; ★Poloumordwinoff, D. **1902.1**; Ranvier, L. A. 1872.1, 1875.1; Remak, R. 1856.1; Retzius, M. G. 1898.2 (*Raja*); Rouget, C. 1865.1, 1876.2; Savi, P. 1841.1, 1844.1; Wagner, R. 1847.1,.4.

PHYSIOLOGY AND FUNCTIONS

Production of Electricity

General treatises. ★Garten, S. **1910.1**; Matteucci, C. 1844.1; Valentin, -. 1842.1; ★Biedermann, W. Add. **1895.1.**

Researches dealing with the subject as a whole. Babukhin, A. I. 1876.1; Du Bois-Reymond, E. H. 1848.1, 1850.1, 1853.1, 1865.1; Fritsch, G. T. 1891.1,.2; Helmholtz, W. 1853.1; Pacini, F. 1846.1–1853.1; Volta, A. 1797.1, 1801.1; Gotch, F. Add. 1900.1.

Historical accounts, development of our knowledge and ideas of the ancients. Keferstein, W. M. 1859.1; Pouchet, G. 1879.2; Du Bois-Reymond, E. H. Add. 1843.1.

Effect of electrical discharge. —*Electrolysis of salts.* Du Bois-Reymond, E. H. 1862.1. —*Narcosis produced.* Engelen, - 1912.1. —*Comparison with Voltaic pile and thermoelectric pile.* Pacini, F. 1852.1, 1853.1.

Source of electricity. Delarive, A. 1871.2

Electrical Fishes — *Cont'd.*
Matteucci, C. 1847.2,.3; Moreau, F. A. 1860.2,.4; Anon. 626.

Construction of successful working models of electrical fishes. Baur, E. 1913.1; Cavendish, H. 1776.1.

Alleged electrical power of Silurus glanis. Vouga, C. 1866.1.

Electrical production; Gymnotus. *Functions of electrical organs, etc.* Allamand, J. N. 1776.1; Bajon, – 1774.1, 1779.1; Faraday, M. 1839.1; Gronovius, L. T. 1760.1; ★Humboldt, F. H. & Bonpland, A. J. 1805.1, 1820.1; Leroy, J. B. 1776.1; Letheby, H. 1843.1,.2; Marey, E. J. 1879.1,.2; Miranda, D. & Puci, G. M. 1845.1,.2; ★Sachs, C. 1877.1,.2, **1881.1**; Schönbein, C. F. 1841.1,.2,.3; Termeyer, R. M. 1781.1; Williamson, H. 1775.1; Delius, H. F. Pre-Linn. 1752.1.

Medical properties. Lott, F. 1762.1. — *Employment as medical shock-machine by natives of Surinam.* Wilson, G. 1857.1, 1860.1.

For Anatomy *of electrical organs, see above.*

Malopterurus. Broussonet, P. M. 1782.2; Cremer, M. 1912.1; Du Bois-Reymond, E. 1881.2, 1882.1, 1891.1; Gotch, F. 1899.1, Add. 1886.1, 1895.1; ★Gotch, F. & Burch, G. J. 1896.1, 1897.1, 1900.1; ★Koike, I. **1910.1**; Logeman, W. M. 1863.1. — *Periodical activity of spinal ganglion cells of Malopterurus in electric discharge.* Garten, S. 1910.2. — *Using electric power to obtain food.* Stirling, A. B. 1878.2.

Torpedo. *For* Anatomy *of electrical organs, see above.*

General researches on electrical functions. Cremer, M. 1909.1; ★Davy, J. 1829.1, 1832.1, 1834.1, Add. 1835.1; Du Bois-Reymond, E. H. 1888.1, 1893.1, Add. 1889.1; Eckhard, C. 1858.1; Fuchs, R. F. 1900.1; ★Garten, S. **1900.1**, Add. 1900.1; ★Gotch, F. 1888.1, 1889.1, Add. 1887.1–1888.2; Linari, S. 1832.1-1839.1; Lemoine-Moreau, E. 1868.1; ★Matteucci, C. 1836.1–1862.1; Pringle, J. 1775.1,.2, 1779.1, Add. 1783.1; Schoenlein, K. 1895.2, Add. 1896.1; Spallanzani, L. 1783.1,.2,.3; Volta, A. 1807.1; Walsh, J. 1774.2; Zantedeschi, F. 1841.1–1852.1.

Effects of electrical discharge. —*On marine animals.* Carazzi, D. 1897.1. — *In formation of urea.* Gréhant, L. F. & Jolyet, F. 1891.1. — *Discharge in fresh water.* Kreidl, A. & Kinoshita, T. 1910.1. — *Intensity and duration.* Delarive, A. 1871.1; Marey, E. J. 1871.1–1879.1. — *Immunity of Torpedo to its own shock.* Jobert, C. & Jolyet, F. 1895.1; Steiner, J. 1874.1; Anon. 561.

Thermo-dynamics of discharge. ★Bernstein, J. & Tschermak, A. 1904.1, **1906.1**. — *Chemical interchanges.* Marcuse, W. 1891.1; Röhmann, F. 1893.1; Weyl, T. 1881.1–1883.1, Add. 1883.1. — *Transformation of forces.* Rouget, C. 1879.1.

Medical use of the shock. Frenzel, J. S. Add. 1777.1; Kaempfer, E. Pre-Linn. 1694.1.

Researches with oscillograph on isolated electric organ of Astrape. ★Fuji, K. Add. **1914.1.**

Miscellaneous papers. Arsonval, A. 1895.1; Becquerel, A. C. 1837.1, 1862.1; Breschet, G. & Becquerel, A. C. 1835.1, 1836.1; Couch, J. 1823.1; François-Franck, C. A. 1879.1; Gay-Lussac, L. J. & Humboldt, A. 1805.1; Home, E. 1816.2; Ingenhousz, J. 1775.1; Jolyet, F. 1883.1; Jolyet, F. & Rivière, P. 1895.1; Leroy, J. B., Walsh, J. & Seignette, – 1774.1; R., A. de L. 1862.1; Schilling, G. W. 1808.1; Soave, F. 1781.1; Stassano, H. 1883.1; Todd, J. T. 1816.1, 1817.1; Vada, H. 1862.1; Vassalli-Eandi, A. M. 1799.1; Eisig, H. Add. 1883.1.

Pre-Linn. *references.* Cramer, A. 1710.1; Kircher, A. 1643.1–1678.2; Réaumur, R. A. 1741.1. — *Important researches.* Lorenzini, S. 1678.1; Redi, F. 1671.1.

EMBRYOLOGY OF FISHES

Comprising the developmental stages subsequent to the fertilization of the ovum.

The various divisions and sub-divisions of this subject are so closely interrelated that there should be constant cross reference from one division to related ones. In some cases such cross references are noted herein.

For earlier stages of development, *i. e.* those preceding fertilization, *see* Oogenesis and maturation *under* Ova and Ovum.

For later stages of development, *see* Larvæ *under* Planktonic fauna.

For the development of individual types, *see under* the various genera, families, and higher groups.

For the development of particular organs, and systems, *see under* such topics as Air bladder; Electrical organs; Eye; Head; Heart; Pancreas; Urino-genital system, etc.

For the development, not primarily embryological, of viviparous fishes *see* Viviparity *under* Reproduction.

For the metameric arrangement of embryological structures, particularly of the central nervous system and mesoderm, *see under* Metamerism.

For methods of study in embryology *see under* Technique and Methods of Study.

General treatises

General treatises on the comparative embryology of vertebrates, including fishes.

Text in English. Balfour, F. M. 1880.1; Beard, J. 1896.2; Foster, M. & Balfour, F. M. 1874.1, 1883.1; ★Kellicott, W. E. 1913.1,.2; McMurrich, J. P. 1913.1; Marshall, A. M. 1893.1; Agassiz, J. L. Add. 1849.1.

Text in French. Houssay, F. 1893.1.

Text in German. ★Hertwig, W. A. 1888.1, 1906.2, 1910.1; Levy, O. 1913.1; ★Oppel, A. 1891.1, Add. 1914.1; Rathke, M. H. 1861.1; Schenk, S. L. 1874.3; Schneider, A. F. 1879.1; Treviranus, G. R. 1828.1; ★Ziegler, H. E. **1902.1**.

Text in Russian. Mitrofanov, P. I. 1892.3.

For the most recent and valuable treatise in English on vertebrate embryology (mammalia excepted), see ★Kerr, J. G. Text-book of Embryology. Vol. II, Vertebrata. London, 1919. 591 p.

For a bibliography of vertebrate embryology prior to 1893, see Minot, C. S. Add. 1893.1.

VARIOUS TOPICS

In aquarium at Hamburg, eggs of Scyllium canicula hatch in from eight to nine months, S. catulus in five or six months. Bolau, C. C. 1881.1. — *Eggs of dogfish (Squalus), kept in tidal pool at Concarneau, hatch in nine months after laying.* Coste, J. J. 1867.1.

The bearing of the embryology of the lower fishes on vertebrate morphology. Kerr, J. G. 1906.1.

Softening of egg membranes by digestive ferment at time of hatching. Kerr, J. G. 1901.1; Wintrebert, P. 1912.1,.2. — *Hatching of ovum as an osmotic phenomenon.* Philippson, M. 1912.1.

Weight of developing eggs. Ritter, W. E. & Bailey, S. E. 1908.1.

Miscellaneous and general papers on embryology. Baer, K. E. 1829.1, 1836.3; Balfour, F. M. 1875.1; Beard, J. 1896.2, 1897.1; Budgett, J. S. 1901.1; Conklin, E. G. 1905.1; Filippi, F. 1841.1, 1845.2, 1846.1, 1847.1,.2; Gaskell, W. H. 1898.1 (xii); Goette, A. 1869.1; Janosík, J. 1883.2; Kölliker, R. A. 1850.1; Kollmann, J. 1885.1; Lanzi, L. 1908.1; Lebert, H. 1845.1; Minot, C. S. 1901.2; Pouchet, G. 1872.4; Ryder, J. A. 1882.9, 1883.1; Sedgwick, A. 1910.1; Sundevall, C. J. 1851.2, 1852.1, 1855.1; Valentin, G. G. 1850.1; Vogt, C. C. 1842.2.

Experimental Embryology

Polyembryony (experimental). Bataillon, E. 1900.3. — *Blastodisks of rays cut in fragments fuse to form new disks.* Eismond, J. 1910.1,.2. — *Number of cells in larvæ from isolated blastomeres, Amphioxus.* Morgan, T. H. 1896.1.

Immunity of Fundulus eggs to electrical stimulation. Brown, O. H. 1903.1. — *Centrifuging, effects on development of eggs.* Stein, S. T. 1909.1.

Changes in chemical energy in developing eggs. Glaser, O. C. 1912.1,.2,.3. — *Differences of electrical potential in developing eggs.* Hyde, I. H. 1905.1. — *Chemical changes in developing egg.* Levene, P. A. 1901.1.

Colored lights, influence on development, Gadus and trout. Grein, H. 1914.1; Supino, F. 1910.2. — *Sunlight, harmful influence to eggs.* Millet, C. 1855.2; Page, W. F. 1885.1.

Effects or influence on developing (fish) eggs of — Alkaloids. McClendon, J. F. 1912.2. — *Alcohol and lithium chloride.* Stockard, C. R. 1906.1, 1907.3, 1909.3, 1910.4. — *Radium.* Tur, J. 1906.1–1913.1. — *Oxygen deficiency.* Loeb, J. Add. 1893.1, 1896.1.

Resistance of ova to mechanical injury. Steuert, L. 1905.1. — *Experimental studies (with cautery).* Sumner, F. B. 1903.1, 1904.2.

Influence of temperature on rate of development. Johansen, A. C. & Krogh, A. Add. 1914.1; Krogh, A. Add. 1914.1.

For related topics, see Experimental researches *under* Physiology, *and later in this section,* Germ ring *under* Gastrulation.

For the artificial production of monstrosities, see under Experimental results, *and* Cyclopia *under* Teratology.

Origin and migration of germ cells

Including "segregation of germ cells."

Papers recording this process in — Amia and Lepidosteus. ★Allen, B. M. 1911.1. — *Pristiurus, Raja, etc.* Beard, J. 1901.1–1904.1, Add. 1902.1. — *Lophius.* Dodds, G. S. 1910.1. — *Embiotocidæ.* Eigenmann, C. H. 1891.1,.4, 1896.1, .3. — *Salmo.* Federow, V. 1907.1. — *Opsanus.* Sink, E. W. 1912.1. — *Squalus.* Woods, F. A. 1902.1. — *Amiurus.* Bachmann, F. M. Add. 1914.1. — *General article.* ★Waldeyer, W. Add. 1901.1.

For Oögenesis and maturation of ovum, see under Ova and Ovum.

Parthenogenesis

The subject of parthenogenesis in vertebrates has been fully reviewed by ★R. Bonnet *in* Ergebnisse der Anat. u. Entwickelungsgeschichte (Anat. Hefte), 1899, Band ix, 820–870.

While in vertebrates parthenogenesis does not occur naturally, the cleavage of unfertilized eggs in the ovaries of fishes has been reported in — Cod. Burnett, W. J. *in* Proc. Amer. Acad. Arts & Sci., 1857, vol. iii, p. 44. — *Trout.* Oellacher, J. 1872.1 (p. 405). — *Pickerel.* Sturtevant, E. L. 1877.1. — *Remarks on this.* Brooks, W. K. 1877.1.

Such intra-ovarian segmentation was noticed in cod, hake, haddock and whiting, and thought to indicate viviparity. Agassiz, J. L. 1856.11.

Eggs of Amphioxus show a tendency to divide if not fertilized. Stricht, O. 1896.1.

The only researches known to us on fishes, wherein artificial parthenogenesis has been induced by chemicals, are those of Bataillon, E. 1900.6, 1903.1, 1904.1.

Sex-determination in fishes

"The sex-chromosome formula has not been definitely established, either cytologically or genetically."

"There is some evidence, however, that they are of the type, female XX, male XY," through the researches on hybrid viviparous Pœciliidæ of Gerschler, W. M. Add. 1914.2.

For confirmatory results and a genetical analysis, see ★J. S. Huxley *in* Journal of Genetics, 1920, vol. 10, pp. 265–276.

For a further discussion bearing on this subject, see under Sex-ratio.

In the Pœciliid Lebistes, O. Winge (Journ. Genetics, 1922, 12, pp. 145–162) *has demonstrated cytologically the XX, Xy condition.*

From his studies on the germ cells of Raja and Pristiurus, Beard concluded that sex is pre-determined in the egg and that

Embryology — *Cont'd.*

the sperm can have no influence. Beard, J. 1902.1–1904.1.

EARLY STAGES in development

The following papers deal collectively with early stages of development, fertilization, cleavage, invagination, etc., in the following groups. The separate phases of development will be found below under the various headings. In general these papers do not treat of the subject beyond the formation of the embryo.

For papers dealing with the whole developmental history of the fishes named, see the final sub-section, Embryology and development of various fishes, *below.*

Early stages of development in Amphioxus. MacBride, E. W. 1898.1, 1900.1.

Early stages in Petromyzon. McClure, C. F. 1893.1.

Early development in Elasmobranchii. Dean, B. 1901.1; Eigenmann, C. H. & R. S. 1889.11.

Early stages of development in — Ganoidei generally. Dean, B. 1896.4. — *Amia.* ★Dean, B. 1895.2,.6; Lanzi, L. 1909.2. — *Lepidosteus.* Beard, J. 1889.3; ★Dean, B. 1895.3,.6; Lanzi, L. 1909.2. — *Acipenser.* ★Dean, B. 1895.3,.6.

Early stages in Teleostei generally. Agassiz, A. 1883.1; Aubert, H. 1853.1, 1854.1; Bambeke, C. 1876.1; Browne, F. B. 1907.1; Cunningham, J. T. 1891.5; ★Hoffmann, C. K. 1880.1, 1881.1, 1883.2; Kovalevski, M. 1886.2; Lanzi, L. 1909.3; Meek, A. 1913.2; Prince, E. E. 1886.1.

Early stages in certain Teleosts. — Trachinus. Boeke, J. 1903.4. — *Perca.* Derjugin, K. M. 1901.1. — *Perca and Cyprinus.* Rusconi, M. 1835.3, 1836.2,.3. — *Cymatogaster.* Eigenmann, C. H. 1892.3. — *Salmonidæ.* Klein, E. E. 1872.2, 1876.1; Oellacher, J. 1873.3, 1879.1; Ovsyannikov, F. V. 1874.1. — *Lebias.* Mazza, F. 1902.1. — *Clupea.* Dixon, B. I. 1913.1; Kupffer, C. W. 1878.1; Pouchet, G. & Biétrix, E. 1889.1,.2. — *Liparis.* Platner, G. 1888.1. — *Noturus.* Sumner, F. B. 1899.1. — *Esox.* Truman, E. B. 1869.1. — *Serranus.* ★Wilson, H. V. 1891.1.

Streaming of protoplasm

Descriptions of the streaming of the protoplasm to form the germinal disk in Teleostei. Coste, P. 1850.1; Gerbe, Z. 1875.1; Henneguy, L. F. 1881.1; Pouchet, G. & Biétrix, E. 1889.1.

For other references to the streaming of the protoplasm, see under Fertilization, *and under* Segmentation.

FERTILIZATION

General accounts of the fertilization of the ovum. Blanchard, R. 1879.1; ★Hertwig, C. W. **1903.1**; ★Rabl, C. **1915.1.**

Miscellaneous items, comprising notes, observations, etc. Anderson, J. 1800.1; Bastard, – 1812.1; Bell, C. 1874.1; Küchenmeister, G. F. 1866.1; Kupffer, C. W. 1877.1; Ransom, W. H. 1855.1; Schücking, A. 1904.1.

Fertilization. — Early effects. Bambeke, C. 1872.1. — *Affecting temperature of water containing the eggs.* Coleman, N. 1872.1; Hartshorne, H. 1872.1. — *Causing decrease in size of ovum, Lampetra.* Okkelberg, P. 1914.2.

Sperm extracts (salmon), effect upon ova. Cremer, M. 1900.1. — *Fertilization with sperm contained in alcohol.* Lebedintsev, A. A. & Nedšoivin, A. 1912.1. — *Effects of radium treated spermatozoa.* Oppermann, K. 1913.1.

Centrosome, role in fertilization. Czermák, N. 1903.1. — *Rotation of yolk after fertilization, Esox.* Reichert, C. B. 1856.2. — *Polyspermy.* ★Rückert, J. 1910.1, Add. 1892.2.

Fertilization of the egg of Amphioxus. Panceri, P. 1867.2; ★Sobotta, J. 1897.2, Add. 1895.1; Stricht, O. 1896.1.

Fertilization of ovum of Cyclostomata (Petromyzon). Böhm, A. A. 1887.1, 1888.1; Calberla, E. 1877.1; Herfort, K. V. 1899.1, 1900.1; Kupffer, C. W. & Benecke, B. 1878.1; Müller, A. 1864.1.

Fertilization of the egg of — Selachii. Rückert, J. 1891.1, Add. 1891.1. — *Acipenser.* Zalenskiĭ, V. V. 1878.1.

Fertilization of eggs of Teleostei. ★Agassiz, A. & Whitman, C. O. 1885.1,.2, 1891.1. — *Clupea.* Arnold, J. N. 1906.1; Ewart, J. C. 1884.3. — *Clinus.* Gintel, F. 1892.1. —*Gasterosteus.* Ransom, W. H. 1854.1. — *Eels.* Syrski, S. 1875.2, 1876.1. — *Pomotis.* Wyman, J. Add. 1863.1.

Fertilization in Salmonidæ. ★Behrens, G. 1898.1; Blanc, H. 1891.1, 1892.1, 1894.1, 1898.1,.2,.3; Böhm, A. A. 1891.1; Davy, J. 1854.1; Kupffer, C. W. 1886.1; Oellacher, J. 1873.2.

For Cross-fertilization experiments, *i. e. fertilization of ova with sperm of remotely related species, see under* Hybrids and hybridization.

Many embryologists have artificially fertilized fish ova during their studies. Such efforts are recounted in many of the foregoing papers. The following references especially refer to artificial fertilization in these forms. — Prototroctes. Allport, M. 1869.3. — *Goldfish.* Berkhouse, J. R. 1909.1. — *Cantharus.* Künstler, J. 1893.1. — *Cristiceps.* Kopsch, F. 1902.2.

For Methods of artificial fertilization *used in fish culture, see that subject in section on* Pisciculture.

CLEAVAGE OR SEGMENTATION

For a general treatise on the cleavage of the ovum, see ★Sobotta, J. Add. **1897.1.**

Alternation of periods of rest with periods of activity in segmentation (Batrachus). Brooks, W. K. 1883.1.

Relation of first cleavage plane to the future embryonic axis. Bataillon, E.

1896.4; Cerfontaine, P. 1905.2; Clapp, C. M. 1898.1; Rauber, A. 1883.1.

Symmetry of first segmentation furrows of blastodisk, elasmobranchs. Ryder, J. A. 1886.9.

Miscellaneous and general accounts on the cleavage of the ovum. Aubert, H. 1853.1; Bambeke, C. 1872.1–1876.1; Coste, P. 1850.2; Ecker, A. 1852.1; Lereboullet, D. A. 1864.1,.3; Newman, H. H. 1910.1, 1914.1; Norman, W. W. 1896.1; Oellacher, J. 1875.1; Rauber, A. 1883.2; Sanzo, L. 1915.2 (i).

Holoblastic cleavage

Holoblastic or complete cleavage of the ovum. *In Cyclostomata (Petromyzon).* Calberla, E. 1877.1; Glaesner, L. 1910.2; Herfort, K. V. 1899.1; McClure, C. F. 1893.1; Rauber, A. 1883.1.

Holoblastic cleavage in Ganoidei. — Acipenser. ★Dean, B. 1895.3,.6; Peltzam, E. D. 1887.1; Zalenskiĭ, V. V. 1878.1. — *Amia.* ★Dean, B. 1895.2; Virchow, H. 1896.1,.2; ★Whitman, C. O. & Eycleshymer, A. C. 1897.1. — *Lepidosteus.* ★Dean, B. 1895.3,.6; Eycleshymer, A. C. 1899.1, 1903.1. — *Polypterus.* Kerr, J. G. 1907.2.

Holoblastic segmentation of eggs of Dipnoi. — Protopterus. Budgett, J. S. 1900.5. — *Lepidosiren.* Kerr, J. G. 1900.1. — *Neoceratodus.* Semon, R. W. 1901.2.

Meroblastic cleavage

Meroblastic or partial segmentation. *In eggs of Elasmobranchii, taking place during their descent through the oviduct.* Coste, P. 1847.1; Gegenbaur, C. 1861.1; Gerbe, Z. 1872.2,.3; Kollmann, J. 1886.2; ★Rückert, J. **1899.1**; Ryder, J. A. 1887.1; Kastchenko, N. Add. 1894.2.

Meroblastic segmentation in Chimæra. ★Dean, B. 1906.1.

Reminiscence of holoblastic cleavage in Cestracion. Dean, B. 1901.5.

Meroblastic segmentation of eggs of Teleostei. General papers. ★Agassiz, A. & Whitman, C. O. 1885.1 (ii),.2, 1891.1; Bataillon, E. 1896.3; Beneden, E. 1877.1; ★Fusari, R. 1887.2, 1892.1, 1895.1; Janosík, J. 1883.1, 1885.2; Kœhler, R. & Bataillon, E. 1893.2; Meek, A. 1913.2; Rudnev, V. G. 1899.2; Kovalevski, M. Add. 1885.1.

Partial segmentation in eggs of certain Teleosts. — Perca. Derjugin, K. M. 1901.1. — *Siphostoma.* Gudger, E. W. 1905.1. — *Salmo.* Kopsch, F. 1911.1; Ryder, J. A. 1882.7. — *Belone.* Kopsch, F. 1901.1. — *Lebias.* Mazza, F. 1902.1. — *Brook trout.* Oellacher, J. 1872.1. — *Gadus and Motella.* Haeckel, E. Add. 1875.1.

Periblast

Also known as "Dotterorgan," "merocytes," and "yolk-syncytium." It should not be confused with the "yolk-nucleus or vitelline body," which is to be found *under* Ovarian ovum *under* Ova and ovum.

For a general treatise on the structure, development and derivatives of the periblast, see ★His, W. Add. **1900.1**.

General researches on the origin, structure, and development of the periblast. Filippi, F. 1860.1; ★Hoffmann, C. K. 1888.1; ★Raffaele, F. 1899.1; Vejdovský, F. & Mrázek, A. 1898.1; ★Virchow, H. 1892.1, Add. 1897.1; Henneguy, L. F. Add. 1882.2.

Structure, development, etc., in Elasmobranchii. Eismond, O. P. 1898.1; His, W. 1897.1; Rückert, J. 1885.1, Add. 1890.1. — *Scyllium.* Beard, J. 1896.5; Eismond, J. 1903.1. — *Comparative differences in formation in various Selachii.* Virchow, H. 1897.2. — *In Chimæra.* Dean, B. 1906.1.

Periblast of Teleostei, structure, etc. Bataillon, E. 1896.1, 1900.1; Berent, W. 1896.1; Brook, G. 1887.3; Corning, H. K. 1896.1; ★Kopsch, F. 1902.1; Reinhard, W. 1898.1,.2, 1899.1; Wenckebach, K. F. 1886.1; Ziegler, H. E. 1894.1, 1896.1; Golovine, E. Add. 1891.1.

Periblast in certain Teleosts and in Lepidosteus. — Esox. Berg, L. S. 1899.2. — *Belone.* ★Kopsch, F. 1901.1. — *Labridæ.* List, J. H. 1887.4. — *Salmonidæ.* Rieneck, – 1869.1; Virchow, H. 1894.2, 1895.1. — *Lepidosteus.* Beard, J. 1896.5.

For other papers containing references to the periblast, see under Cleavage *and also under* Early stages.

GASTRULATION

formation of gastrula

For general treatises on gastrulation in fishes, see ★Kopsch, F. **1904.1**, *and* ★Keibel, F. Add. **1900.1**.

Gastrulation in Amphioxus. Klaatsch, H. 1897.1, 1898.1; MacBride, E. W. 1908.1; ★Morgan, T. H. & Hazen, A. P. 1900.1; ★Sobotta, J. 1897.1.

In Cyclostomata (Petromyzon). ★Glaesner, L. 1910.1,.2; ★Hatta, S. 1907.1; Selys-Longchamps, M. 1910.1. — *In Bdellostoma.* ★Dean, B. 1899.6.

Gastrulation in Ganoidei and Neoceratodus. — Amia. Brachet, A. 1912.1; Eycleshymer, A. C. & Wilson, J. M. 1906.1; Sobotta, J. 1896.1. — *Acipenser and Lepidosteus.* ★Dean, B. 1895.3,.6. — *Neoceratodus.* Semon, R. W. 1901.2.

Gastrulation in Teleostei in general. Boeke, J. 1907.2; ★Corning, H. K. 1896.1; Dean, B. 1895.7; Henneguy, L. F. 1880.1; Kovalevski, M. 1886.1; Sobotta, J. 1898.1; Sumner, F. B. 1900.2; Ziegler, H. E. 1887.2.

Gastrulation in certain Teleosts. — Coregoninæ. Auerbach, M. 1904.1. — *Murænidæ.* Boeke, J. 1903.1. — *Salmon.* Goette, A. 1873.1. — *Gadus and Motella.* Haeckel, E. Add. 1875.1.

Specific researches on various problems in gastrulation. — Gastrulation in meroblastic ova. Kupffer, C. W. 1884.1. — *Influence of yolk on gastrulation in Teleosts.* Cunningham, J. T. 1885.2. — *in Selachii and Teleostei.* Samassa, P. 1896.1.

Embryology — *Cont'd.*

— *Gastrulation in double embryos of trout.* Schmitt, F. 1902.1.

Blastopore

The primitive opening into the archenteron formed by gastrulation.

Relation to primitive streak. Bellonci, G. 1884.1. — *Asyntaxis, Amphioxus.* Legros, R. 1907.1. — *Blastopore of Selachians.* Ostroumov, A. A. 1889.1.

Prostomial thickening of dorsal lip of blastopore, Ganoids and Teleosts. Lanzi, L. 1909.2,.3.

Yolk blastopore, position determined by size of vitellus. Ryder, J. A. 1885.12. — *Persistence of blastopore in Petromyzon.* Shipley, A. E. 1886.2, 1887.1.

Germ ring

Structure and development in — Teleostei. Corning, H. K. 1896.1. — *Batrachus.* Wallace, L. B. 1899.1.

Experimental researches on development, Salmonidæ. Kopsch, F. 1896.2. — *Experiments on localization and regeneration in Fundulus.* Lewis, W. H. 1912.1,.2.

Germ layers
Origin and development

General treatises. Assaky, G. 1886.1; ★Hertwig, W. A. Add. 1903.1; ★Keibel, F. Add. **1900.1**.

Miscellaneous and general papers. Hertwig, W. A. 1901.1; Lvov, V. N. 1893.1,.3, 1894.1; Nicolucci, G. 1844.1; Perenyi, J. 1889.1; Samassa, P. 1895.1.

Formation of the germ layers in the lower fishes and in Neoceratodus. — Petromyzon. Hatta, S. 1892.1; Selys-Longchamps, M. 1910.1. — *Amphioxus.* MacBride, E. W. 1896.1, 1908.1, 1909.1. — *Selachii.* Rückert, J. 1885.1, 1889.1; Swaen, A. 1885.1. — *Neoceratodus.* Semon, R. W. 1901.2.

Development of germ layers in Teleostei generally. ★Berent, W. 1896.1; Brook, G. 1887.1; Lanzi, L. 1909.1, 1910.1; Moquin-Tandon, G. 1875.1; ★Swaen, A. & Brachet, A. 1902.1, 1904.1; Kovalevski, M. Add. 1885.1; Sumner, F. B. Add. 1899.1.

Formation of germ layers in certain Teleostei. — Murænidæ. ★Boeke, J. 1903.1. — *Salmonidæ.* ★Goronowitsch, N. 1885.1; Henneguy, L. F. 1882.1; Ovsyannikov, F. V. 1874.1. — *Cyprinidæ.* Reinhard, W. 1888.1.

Researches on specific problems relating to the germ layers. — Origin and significance of the germ layers. Lankester, E. R. 1873.3, 1877.1. — *Influence of yolk on development of germ layers.* Samassa, P. 1896.1. — *Development in terminal bourgeon and in tail of Teleosts.* Swaen, A. & Brachet, A. 1902.1, 1904.1.

For the part of the germ layers in the "Origin of pronephric duct," see this heading under Urinogenital System.

ECTODERM OR EPIBLAST

Limit in mouth. Johnston, J. B. 1909.2. — *Organs, derived from.* Kupffer, C. W. 1895.1. — *Relation to development of mesenchyme.* Lundborg, H. 1899.1.

ENTODERM OR ENTOBLAST

Development in Murænoids. Boeke, J. 1902.1. — *Entoderm of digestive system, origin in Amia.* Brachet, A. 1912.1. — *Origin in Teleosts.* Brook, G. 1885.8. — *Derivatives from.* Hoffmann, C. K. 1892.1, 1893.2. — *Limit in mouth.* Johnston, J. B. 1909.2.

Yolk-sac entoderm, development. Kopsch, F. 1901.1, 1902.1, 1911.1; His, W. Add. 1900.1. — *"Secondary entoderm" of teleosts.* Gensch, H. Add. 1882.1.

MESODERM OR MESOBLAST

For a general treatise on the origin of the mesoderm and on the organs derived from it, see ★Rabl, C. Add. **1889.1** *and* **1897.1.**

Miscellaneous and general papers on the origin and development of the mesoderm. Lvov, V. N. 1894.1; Minot, C. S. 1890.2; Perenyi, J. 1891.1.

Development of the mesoderm in Amphioxus and Petromyzon. — Amphioxus. ★Garbowski, T. 1898.1; Sarasin, P. 1889.1. — *Petromyzon.* Shipley, A. E. 1886.2.

Development of the mesoderm in Elasmobranchii. Balfour, F. M. 1877.1; Hertwig, W. A. 1883.1; Hoffmann, C. K. 1883.1; Rückert, J. 1887.1; Virchow, H. 1898.2; Wijhe, J. W. 1882.2, 1889.1.

Development of mesoderm in Teleostei. Boeke, J. 1903.2; Borcéa, J. 1909.2. — *Murænidæ.* Boeke, J. 1902.1, 1903.1. — *Salmonidæ.* Sobotta, J. 1894.1; Henneguy, L. F. Add. 1882.1.

Development of the head mesoblast in Dipnoi and Ganoidei. — Head mesoblast in Dipnoi. Agar, W. E. 1907.1. — *Neoceratodus.* Gregory, E. H. 1905.1; Greil, A. 1907.1. — *Head mesoblast, Amia.* Reighard, J. E. & Phelps, J. 1908.1.

Development of the head mesoblast in Torpedo and Pristiurus. Emmert, J. 1900.1.

Mesoblast as an organ anlage. Borcéa, J. 1909.2; Schenk, S. L. 1868.1; Swaen, A. & Brachet, A. 1899.1,.2. — *Share in formation of pectoral fin in Teleostei.* Boyer, E. R. 1892.1. — *Gastral mesoderm doubtfully existent.* Raffaele, F. 1901.1.

MESENCHYME

Mesoblastic tissue derived mainly from the mesoderm, but also in small part from the entoderm.

Origin and development. ★His, W. Add. **1900.1.** — *Acipenser.* Tichenko, S. 1906.1. — *Selachii.* Ziegler, H. E. 1891.1.

A source of connective tissue. Kollmann, J. 1883.1, 1884.1; Szily, A. 1908.1.

EMBRYO FORMATION

General treatises. His, W. 1894.3; ★Kopsch, F. **1904.1;** Morgan, T. H. 1895.1; Keibel, F. Add. 1902.1.

Miscellaneous. Brachet, A. 1905.1; Kœhler, R. & Bataillion, E. 1893.2; Kastchenko, N. Add. 1894.1.

Embryo formation in — Elasmobranchii. His, W. 1877.1,.2; Schultz, A. 1875.1,.2. — *Amia.* Eycleshymer, A. C. & Wilson, J. M. 1906.1. — *Acipenser.* Zalenskiĭ, V. V. 1879.1.

Embryo formation in Teleostei. Henneguy, L. F. 1887.1; Kupffer, C. W. 1867.1; Reis, K. 1911.1. — *Embryonic anlage, Salmonids.* Auerbach, M. 1904.1; Goronowitch, N. 1885.1.

Development of organs in Pristiurus, Torpedo, Herring, and Trout. Oppel, A. 1891.1. — *Gadus.* Ryder, J. A. 1884.3. — *Acipenser.* Zalenskiĭ, V. V. 1879.1.

Neurenteric canal and neuropore, structure and development. Kopsch, F. 1896.1; Kupffer, C. W. 1887.1; Stendell, W. 1914.1. — *Phylogeny of neuropore.* Ayres, H. Add. 1907.1.

Primitive streak, the region on either side of the primitive groove which is formed by the concrescence of the lips of the blastopore. — *In Gymnarchus.* Assheton, R. 1907.2. — *Development.* Bellonci, G. 1884.1; Kupffer, C. W. 1884.1. — *In Teleosts.* Henneguy, L. F. 1885.1, Add. 1884.1. — *In meroblastic ova.* Kollmann, J. 1886.1. — *In Scyllium.* Kopsch, F. 1898.2.

For the segmental structure of the developing head, see Metamerism *under* Head.

CONCRESCENCE THEORY

Theory of the formation of the fish embryo, by the growing together of the lips of the germ ring.

Disproved by experiments. Morgan, T. H. 1893.1. — *Concrescence theory with reference to gastrulation of double embryos.* Schmitt, F. 1902.1.

Notes, remarks, and researches on the concrescence theory. Eycleshymer, A. C. 1902.1; Glaesner, L. 1910.1; Minot, C. S. 1890.1; Ryder, J. A. 1885.9; Whitman, C. O. 1878.1; ★Virchow, H. Add. 1897.1.

Kupffer's vesicle

A remnant of the archenteron, found in Teleostei and (doubtfully) in Ganoidei.

Relation to recapitulation. Dean, B. 1909.4. — *Morphological significance.* Cunningham, J. T. 1885.1; Reinhard, W. 1898.1,.2; Sobotta, J. 1898.1.

Development in Murænoids. Boeke, J. 1902.1. — *Morphology, Trutta.* Gregory, E. H. 1899.1. — *Homologies.* Kopsch, F. 1900.1. — *Original description.* Kupffer, C. W. 1865.1.

Relation to gastrulation and concrescence. ★Sumner, F. B. 1900.1. — *Development in Teleosts.* Swaen, A. & Brachet, A. 1902.1, 1904.1.

Medullary tube

Formation and development. His, W. 1893.1; ★Locy, W. A. 1893.2, 1894.1. — *Of Teleostei.* Aichel, O. 1897.2. — *Teleostei and Petromyzon.* Calberla, E. 1877.2. — *Teleostei.* Goronowitsch, N. 1885.1; Jablonovskij, J. (*Esox*) 1899.1; Schapringer, A. 1871.1. — *Neoceratodus.* Semon, R. W. 1901.1.

For other papers dealing with this subject, see Development of central nervous system *under* Nervous system.

For segmental structure of the medullary tube, see under Metamerism.

Yolk-sac

Development, structure, etc. Harting, P. 1868.1; McIntosh, W. C. 1887.1 (iii); ★Virchow, H. 1892.1. — *Lepidosteus and Scyllium.* Beard, J. 1896.5. — *Carcharodon.* Sanzo, L. 1910.1.

Role of yolk-sac in larval nutrition, its absorption into the body, etc. Fabre-Domergue, P. & Biétrix, E. 1898.1. — *Absorption in Selachii.* Giacomini, E. 1894.2. — *Various Teleosts.* Ryder, J. A. 1883.1. — *Salmo.* Schumacher, S. 1900.1. — *Pelagic teleosts.* Williamson, H. C. 1897.1. — *Functions and histology, Batrachus.* Ryder, J. A. 1890.2.

For the yolk-sac functioning as a placenta in certain viviparous sharks, see Nourishment of embryo *below* Viviparity *under* Reproduction.

UMBILICAL CORD

Umbilical cord, yolk-sac cord, or "Dotterstrang," of Elasmobranchii; structure. Müller, J. 1842.3; Schenk, S. L. 1874.1. — *Sphyrna.* Gudger, E. W. 1912.1; Leuckart, F. S. 1836.1.

For the umbilical cord functioning in the transmission of food stuffs in viviparous sharks, see Viviparity in various species, *in section on* Reproduction.

EMBRYOLOGY AND DEVELOPMENT OF VARIOUS FISHES

This section consists of papers of a general nature dealing for the most part with the whole developmental history of the following fishes. For particular stages or specific structures, *see* above.

CEPHALOCHORDATA

Embryology and development of Amphioxus. Abendroth, E. R. 1870.1; ★Cerfontaine, P. **1905.1,.2**; ★Hatschek, B. 1881.1, Add. 1884.1, 1888.1, 1893.1; ★Kovalevskiĭ, A. O. 1866.1, 1867.1, 1877.1; Legros, R. 1910.1; Marchand, W. 1909.1; Packard, A. S. 1875.1; Rice, H. J. 1880.1; Schultze, M. J. 1851.1; Willey, A. 1891.1; Eismond, J. Add. 1894.1. — *Multiple and partial development.* Wilson, E. B. Add. 1892.1, 1893.1.

CYCLOSTOMATA

Embryology of Myxine. Dean, B. 1899.3; Home, E. 1815.2; Retzius, M. G. 1889.1.

Bdellostoma. ★Dean, B. 1897.4, 1898.2, **1899.6**; Doflein, F. J. 1899.4; Price, G. C. 1896.1,.2.

Petromyzon — Larger researches. Balfour, F. M. 1885.1; Calberla, E. 1877.3; ★Goette, A. 1888.1, 1890.1; ★Kupffer, C. 1888.1; Müller, A. 1856.1,.2; Nestler, K. 1890.1; ★Nuel, J. P. 1881.1; ★Ovsyannikov, F. V. 1870.1,.2, 1889.1, 1891.2; Schultze, M. J. 1855.1, Add. 1856.1; ★Scott, W. B. 1880.1–1882.1, 1887.1.

Petromyzon. — Shorter articles, notes, etc. Agassiz, J. L. 1850.5; Home, E.

Embryology — *Cont'd.*
1815.2; Jammes, L. 1899.1; Kupffer, C. W. 1888.1; Schneider, A. F. 1873.1; Yarrell, W. 1831.3.

For Ammocœtes, *the larval stage of* Petromyzon, *see under section on* Anatomy.

DIPNOI

Embryology, including descriptions of larval forms. — *Ceratodus.* Caldwell, W. H. 1885.1; ★Semon, R. W. 1893.1; Severtzov, A. N. 1902.1. —*Lepidosiren.* ★Kerr, J. G. 1900.1, 1909.1. — *Protopterus.* Budgett, J. S. 1900.5, 1907.1; ★Kerr, J. G. 1900.1, 1909.1.

ELASMOBRANCHII

General papers on embryology, including descriptions of embryos. Baird, S. F. 1874.16; ★Balfour, F. M. 1874.1, 1876.1, **1878.1**; Sedgwick, A. 1893.1.

Plagiostomi

Sharks and rays. Agassiz, A. 1872.1; ★Leydig, F. **1852.1**; ★Müller, J. **1842.3**; Rathke, M. H. 1827.1 (ii).

Selachii

General embryological papers. Bugnion, E. 1894.1; Dean, B. 1901.1; His, W. 1894.1; ★Hoffmann, C. K. 1896.1; Kastschenko, N. 1888.1; ★Mitrofanov, P. I. 1893.1; Schultz, A. 1877.1.

Embryology of various sharks, including descriptions of embryos. — *Acanthias.* Agassiz, J. L. 1856.8; ★Kovalevskiĭ, A. O. 1870.1; Perugia, A. 1880.1. — *Scyllium.* Bolau, C. C. 1879.1; Marqua, F. 1880.1.

Of various other sharks. — *Cestracion.* Haswell, W. A. 1897.1. — *Mustelus.* Kovalevskiĭ, A. O. 1870.1. — *Pristiurus.* Ungaro, V. 1910.1. — *Scymnus.* Parker, T. J. 1882.1.

Batoidei

Development of Raja. Batarra, G. 1771.2; Boldo, B. M. 1797.1; Malm, A. W. 1877.1; Putnam, F. W. 1870.8; Wyman, J. 1864.1,.2, 1865.1; Beard, J. Add. 1892.1.

Embryology of Torpedo. Emmert, J. 1900.1; Fritsch, G. T. 1883.1; Leuckart, C. G. 1850.1; Perenyi, J. 1886.1; ★Ziegler, H. E. & F. 1892.1.

Holocephali

In addition to splendid plates, the entire literature of the reproduction of chimæroid fishes will be found in ★Dean, B. 1899.5, 1903.5, 1904.10, **1906.1**.

For descriptions of various other fœtal Elasmobranchs, see under Oviparity *and* Viviparity of Elasmobranchii, *under* Reproduction.

GANOIDEI

Embryology and development, including descriptions of larval and post-larval stages. — *General researches.* ★Balfour, F. M. & Parker, W. K. 1882.1; Brandt, J. F. 1865.2, 1866.1; Ziegler, H. E. 1900.1.

Acipenser. Grimm, O. 1910.1; Kovalevskiĭ, A. O., Ovsyannikov, P. & Wagner, R. 1870.1; Ovsyannikov, F. V. 1870.2, 1872.1; Ryder, J. A. 1888.2; ★Zalenskiĭ, V. V. 1876.1–**1881.1**.

Amia. ★Dean, B. 1896.5; Forbes, S. A. 1878.6; Fülleborn, F. 1894.1; Anon. 410.

Lepidosteus. Agassiz, J. L. 1856.4, 1879.1,.2; Fülleborn, F. 1894.1; Wilder, B. G. 1877.1; Wright, E. P. 1878.1, 1879.2.

Polyodon. Barbour, T. 1911.1; Danforth, C. H. 1911.1.

Polypterus. Boulenger, G. A. 1898.5, 1899.8, 1900.9; Budgett, J. S. 1900.5, 1902.1,.2, 1907.1; ★Kerr, J. G. 1904.1, 1907.1, **1907.2**; Guitel, F. Add. 1914.1.

TELEOSTEI

Embryology and development of Teleostei. — *General treatises and larger researches.* Cunningham, J. T. 1889.4; His, W. 1892.1; ★Gregory, E. H. **1903.1**; Kingsley, J. S. & Conn, H. W. 1883.1; ★Kupffer, C. W. 1868.1; ★McIntosh, W. C. 1890.1, 1891.1–1892.1, 1896.3; ★McIntosh, W. C. & Prince, E. E. **1890.1**; Reis, K. 1910.1; ★Ryder, J. A. 1884.3, **1887.2**; Wenckebach, K. F. 1886.1.

Shorter papers. Eigenmann, C. H. & R. S. 1889.5; Holt, E. W. 1892.1; Voskoboĭnikov, M. M. 1901.1; Weil, C. 1872.1; Williamson, H. C. 1898.1.

The larvæ and young of fresh-water Teleosts, and the corresponding stages of marine bony fishes which do not have a pelagic larval life, are found below under the various genera.

For larval and post-larval stages of the embryos of marine Teleosts, see under Planktonic Fauna.

For the embryology and development of Anguilla, Pleuronectidæ, *and* Salmonidæ, *see under these headings in the* Systematic part.

Sub-order Acanthopterygii

Division Gobiiformes. — *Gobius.* Filippi, F. 1841.2, 1846.2; Grisellini, F. 1768.1; Riedel, K. 1913.1, 1914.1.

Division Jugulares. — *Trachinus.* Brook, G. 1885.5. —*Batrachus.* Clapp, C. M. 1891.1; ★Gudger, E. W. 1910.1; Ryder, J. A. 1886.3. — *Pholis.* Ehrenbaum, E. 1897.1 (iii). — *Chirolophis.* Ehrenbaum, E. 1897.1 (iii). — *Lepadogaster.* Guitel, F. 1887.3; McIntosh, W. C. 1885.2. —*Blennius.* Steenstrup, J. J. Add. 1865.1.

Division Perciformes. — *Lucioperca (young).* Borodin, N. A. 1903.1. — *Macropodus.* ★Carbonnier, P. 1869.1–1870.2, 1872.1,.3; Mandée, R. 1907.1; ★Pouchet, G. 1872.5; Anon. 193. — *Micrometrus.* Eigenmann, C. H. 1890.3; Eigenmann, C. H. & R. S. 1889.5. — *Cynoscion.* Eigenmann, C. H. 1902.6. — *Hemichromis.* Konnertz, A. 1913.1. — *Perch.* Lereboullet, D. A. 1854.1,.2, 1862.2. — *Labridæ.* ★List, J. H. 1887.3. — *Heros.* Melnikov, V. S. 1902.1. — *Mullus.*

Prévost, C. 1828.1. —*Bryttus and Pomotis* (*young*). Putnam, F. W. 1861.4. —*Stizostedion.* ★Reighard, J. E. 1890.1; Ryder, J. A. 1887.2. —*Micropterus.* ★Reighard, J. F. 1906.1. —*Serranus.* Ryder, J. A. 1888.1; ★Wilson, H. V. 1891.1. —*Chætodipterus and Roccus.* Ryder, J. A. 1887.2. —*Mesogonistius.* Schaeffer, W. 1904.1. —*Betta.* Stehr, E. 1898.1. —*Bairdiella.* Kuntz, A. Add. 1914.1.

Division Scleroparei. —*Comephorus* (*larvæ*). Dybowski. B. I. 1901.1. —*Cottus.* Ehrenbaum, E. 1897.1 (iii); Nordqvist, O. F. 1899.15,.16, 1900.8. —*Agonus and Cyclopterus.* Ehrenbaum, E. 1897.1 (iii). —*Agonus* (*post-larval stages*). McIntosh, W. C. 1896.4.

Division Scombriformes. —*Caranx.* Holt, E. W. 1893.2. —*Cybium* (*Scomberomorus*). ★Ryder, J. A. 1882.4, 1887.2. —*Elacate.* Ryder, J. A. 1887.2. —*Xiphias.* Sella, M. 1911.1.

Sub-order Anacanthini

Motella. Brook, G. 1885.3. —*Gadus.* ★Ryder, J. A. **1884.3**, 1887.2; Sars, G. O. 1865.1, 1866.1, 1868.1, 1876.1.

Sub-order Catosteomi

Lophobranchii. Canestrini, G. 1871.1, .2; Jacobi, A. 1906.1. —*Syngnathus* (*embryonic development*). Costa, O. G. 1843.1; McMurrich, J. P. 1883.1; Quatrefages, J. L. 1842.1; Smith, W. A. 1890.1. —*Syngnathidæ.* Rathke, M. H. 1837.3. —*Hippocampus.* Ryder, J. A. 1882.2. —*Siphostoma.* Ryder, J. A. 1887.2. —*Gasterosteus.* Ehrenbaum, E. 1897.1 (iii); Horsfall, J. H. 1864.1; Prince, E. E. 1885.2; Coste, – Add. 1859.1. —*Apeltes.* Ryder, J. A. 1882.6, 1887.2. —*Solenostoma.* Willey, A. 1909.2.

Sub-order Haplomi

Pœcilia. Duvernoy, G. L. 1844.1. —*Esox.* ★Lereboullet, D. A. 1854.1,.2, 1861.2, 1862.1,.2; Ryder, J. A. 1887.2; Truman, E. B. 1869.1; Wright, E. P. 1878.1. —*Gambusia.* Ryder, J. A. 1886.7, Add. 1884.1; ★Kuntz, A. Add. **1914.2.** —*Umbra.* Ryder, J. A. 1886.2. —*Fundulus.* Ryder, J. A. 1886.1; Träber-Klotsche, G. 1910.3. —*Anlopus, Chlorophthalmus, and Saurus.* Sanzo, L. 1915.1.

Sub-order Malacopterygii

Gymnarchus. ★Assheton, R. 1907.2; Budgett, J. S. (*larvæ*) 1900.5, 1901.1, 1907.1. —*Hyperopisus* (*larvæ*). Budgett, J. S. 1910.1. —*Clupea.* ★Brook, G. 1885.4; Eigenmann, C. H. & R. S. 1889.5; ★Kupffer, C. W. 1876.2, 1878.1,.2; Nishikawa, T. 1904.1; Schneider, G. 1901.5; Wilson, S. 1861.1. —*Sardine or Pilchard* (*Clupea pilchardus*). Bounhiol, J. P. 1913.1,.2; Cunningham, J. T. 1891.11; Marion, A. F. 1891.2; Roché, G. 1894.2. —*Thymallus.* Fritsch, A. J. 1879.2; Köttl, J. 1878.2. —*Coregonus* (*larvæ*). Nüsslin, O. 1908.1, 1910.1. —*Alosa.* Rice, H. J. 1878.2; Ryder, J. A. 1882.8. —*Osmerus.* Rice, H. J. 1878.3. —*Mallotus.* Schmidt, E. J. 1906.2. —*Engraulis.* Wenckebach, K. F. 1887.1; Nishikawa, T. Add. 1901.1. —*Anchovia.* Kuntz, A. Add. 1914.1.

Sub-order Ostariophysi

Cyprinus. Bloch, M. E. 1782.1; Carbonnier, P. 1872.2, 1873.3; Peters, W. C. (*young forms*) 1871.2; Rusconi, M. 1854.1. —*Gobio.* Knauthe, K. 1891.5; Künstler, J. 1908.3. —*Cobitis.* Nehrkorn, A. 1876.1. —*Cyprinidæ.* Reinhard, W. 1888.2; Camerarius, J. R. Pre-Linn. 1683.1. —*Amiurus.* Ryder, J. A. 1883.3. —*Ictalurus.* ★Ryder, J. A. 1887.2. —*Barbus.* Stansch, K. 1904.1. —*Abramis.* Trybom, F. 1898.1. —*Misgurnus* (*young stages*). Werner, Franz. 1908.2. —*Plotosus* (*young*). Willey, A. 1908.2. —*Danio.* Zimmermann, –. 1904.1. —*Carassius.* ★Brigidi, V. & Trafani, A. Add. 1881.1.

Sub-order Pediculati

Lophius. Collins, J. W. 1880.3; Derjugin, K. M. 1901.3, 1902.1; Prince, E. E. 1891.1.

Sub-order Percesoces

Atherinopsis. Eigenmann, C. H. & R. S. 1889.5. —*Ammodytes.* Ehrenbaum, E. 1897.1 (iii). —*Belone.* Ehrenbaum, E. 1897.1 (iii); Ryder, J. A. 1882.3; Sobotta, J. 1896.2. —*Anabas.* Lönnberg, A. J. 1911.2. —*Atherina.* Marion, A. F. 1894.12. —*Ophiocephalus* (*young*). Willey, A. 1909.1.

Sub-order Symbranchii

Symbranchus. ★Taylor, M. 1913.1. —*Chilobranchus.* Haswell, W. A. Add. 1890.1.

EVOLUTION (*IN FISHES*)

The view of evolution having long been fundamental in morphological research, numerous additional related references will be found under the various organs and systems, *such as* Skull, Visceral skeleton, etc.

For the genetical relations between the air bladder and lung, *see* Homologies with lungs, *under* Air bladder.

For a readable popular summary of the evolution of fishes, see ★Jordan, D. S. 1902.2. *With additions, this is reprinted as chapter 24 in his* 1905.1.

For a somewhat more technical summary, see ★Traquair, R. H. 1900.2.

Various minor topics, recording instances of, or relating to evolution, mutation, recapitulation, selection, etc. Cope, E. D. 1868.2, 1872.2,.4,.16, 1885.2; Dean, B. 1908.2; Dollo, L. 1893.1; Eigenmann, C. H. 1905.1; Eigenmann, C. H. & Cox, U. O. 1900.1; Hussakof, L. 1910.6; Jäger, Gustav 1908.1; Kerr, J. G. 1910.5; Parker, W. K. 1879.1; Peter, K. 1910.1; Popoff, M. 1906.1; Ryder, J. A. 1885.8.

Tadpole considered a stage in the transformation of fishes into frogs. Merian, M. S. Pre-Linn. 1719.1; Seba, A. Pre-Linn. 1734.1.

Fresh-water considered the habitat of the earliest vertebrates. Chamberlin, T. C. 1900.1; Pompeckj, J. F. 1914.1.

Evolution — *Cont'd.*

The origin of fresh-water faunas. Gill, T. N. 1905.12; Palacky, J. 1891.1; Sollas, W. J. 1884.1.

Quadrate and squamosal as progenitors of mammalian temporal. Albrecht, P. 1883.1.

Homologies of the opercular elements of fishes with the auditory ossicles of mammals. Baraldi, G. 1877.1.

Evolution as illustrated by egg-cases of Chimæridæ. Dean, B. 1904.1,.2, 1912.6.

Polymorphism and evidence of mutation in Malthopsis. Lloyd, R. E. 1909.1, 1912.1.

General treatises on Evolution

In the following works, references to the evolution of fishes are usually incidental.

Text in English. ★Darwin, C. R. 1871.1, 1883.1; Lloyd, R. E. 1912.1; ★Morgan, T. H. 1916.1; ★Osborn, H. F. 1894.1, 1916.1; Phillips, J. 1860.1; Cunningham, J. T. Add. 1898.1.

Text in French. Perrier, J. O. 1884.1; Vialleton, L. 1908.1.

Text in German. ★Abel, O. 1912.1; Haacke, J. W. 1893.2; ★Haeckel, E. H. 1895.1; Keibel, F. 1898.1; Rosa, D. 1903.1; Simroth, H. R. 1891.1, 1902.1; Wagner, M. F. 1889.1.

Evolution and Palæontology

The geological succession of life in time being the history of fishes as traced on the older rocks, especially in America. Agassiz, J. L. 1835.3, 1843.2,.4, 1846.4; Case, E. C. 1898.1; Cope, E. D. 1874.7; Marsh, O. C. 1877.1; Meek, S. E. 1900.2; Newberry, J. S. 1873.3; Phillips, J. 1860.1; Pohlig, H. 1909.1, 1914.1.

Palæohistological data on the origin of teleosts. Reis, O. M. 1895.3.

Palæontological evidence for the evolution of fishes. ★Traquair, R. H. 1898.1, 1900.1,.2.

The imperfection of the geological record. Woodward, A. S. 1898.2.

Evolution of vertebrate animals in time, an address. Woodward, H. 1904.1.

Palæontology and the biogenetic law. Zittel, K. A. 1895.2.

The probable derivation of the Amphibia from the Crossopterygian ganoids. Gregory, W. K. 1913.2, 1915.1; Jaekel, O. 1911.1; Moodie, R. L. 1915.1,.3; Pollard, H. B. 1891.1.

Dipnoi considered related to Amphibia but excluded from the direct ancestry because of specializations in skull and dentition. Semon, R. W. 1901.4.

Hypotheses of the ancestry of the vertebrates

Practically all hypotheses on the origin of vertebrates are reviewed in Delage, M. Y. & Hérouard, E. 1898.1, pp. 345–355.

In addition to the following chief hypotheses, a number additional are mentioned by Perrier, J. O. 1898.1.

Annelidan view of the derivation of vertebrates from worm-like ancestors. Various papers discussing suggested annelidan affinities, especially in the nervous system. Beard, J. 1889.4; Bernard, H. M. 1898.1; Dohrn, A. 1876.2; Kovalevskiĭ, A. O. 1877.1; Ryder, J. A. 1885.1; Delsman, H. C. Add. 1913.1; Semper, C. Add. 1875.1.

Arachnid hypothesis of vertebrate ancestry, based on supposed resemblances, especially in appendages of the horseshoe crab Limulus and the Ostracoderms. ★Patten, W. 1890.1, 1902.1, 1906.1, **1912.1.** — *Remarks on these views.* Eastmann, C. R. 1902.5, 1903.2, 1904.4.

Arthropod hypothesis, or Gaskell's view of crustacea as ancestors of the vertebrates. ★Gaskell, W. H. 1889.1–**1908.1.** — *Remarks on these views.* Bordage, E. 1892.1; Dean, B. 1909.3; Jaekel, O. 1909.2; Kerr, J. G. 1910.2; Patten, W. 1899.1.

Concerning Gaskell's hypothesis, the arthropod resemblances are ascribed to parallelisms in Dollo, L. 1909.4.

Cephalic homologies, in relation to the determination of the ancestry of vertebrates. Minot, C. S. 1897.1.

Ostracoderms as forerunners of vertebrates. Woodward, A. S. 1892.5.

Protochordate origin of the vertebrates. " Amphioxus and the ancestry of the vertebrates." Willey, A. 1894.1.

Of morphologists of the highest order, few have been more productive of speculations on the origin of the vertebrates than Anton Dohrn. For these views published in German, see ★Dohrn, A. **1882.2.** *For critical remarks on these views, see* Cunningham, J. T. 1884.1, 1887.1. *For summaries in English of Dohrn's theories, see* ★Scharff, R. F. 1888.2.

Unclassified papers. Goette, A. 1895.1; Jenkins, S. 1897.1; Lillie, R. S. 1896.1.

Origin of species

Origin of species through isolation. Jordan, D. S. 1905.5,.6.

Coregonus fera sancti-benedicti arising from C. fera of Bodensee, after 40 years isolation in Laachersee, Prussia. Thienemann, A. 1911.2, 1912.5, 1914.1.

PHYLOGENESIS OF LIMBS

Hypotheses of the origin of the paired limbs of gnathostomes based primarily on the study of the structure of the fins of fishes.

The paired fins of fishes (Ichthyopterygia) are universally accepted as the progenitors of the limbs (Chiropterygia) of the other classes of vertebrates or tetrapods.

For an excellent, popular résumé of the three prevalent views listed below, see ★Jordan, D. S. **1902.9.** *This is reprinted as chapter v in his* 1905.1.

A shorter résumé largely quoted by Jordan is that of ★Kerr, J. G. 1900.2. *Another (in German) is that of* Jaekel, O. 1909.2.

For a learned summary of the gill-arch and the lateral fold hypotheses with a bibliography, see ★Goodrich, E. S. **1906.1.**

For a scholarly presentation of the phylogenesis of limbs throughout the vertebrates, from the data of comparative anatomy and palæontology, see ★Gregory, W. K. **1915.1.**

EARLIER VIEWS

These are largely summarized in Mivart, St. G. 1879.1 and are repeated in Cope, E. D. 1890.1.

Limbs considered as diverging appendages attached to ribs, with a shoulder-girdle of axial origin. Owen, R. 1848.1.

Limbs considered homologous with epipleural spines, and external to visceral wall of body. Goodsir, J. 1857.1.

Vertical fins considered of bifold origin; paired fins considered portions of lower azygos fins prevented from uniting by interposed body-cavity. Humphry, G. M. 1870.1, 1871.1.

Vertebrate limbs considered as modified ribs by Maclise in Todd, R. B. "Encyclopædia," 1832, vol. 4, p. 70, *and by* Oken, 1843, "Lehrbuch der Natur-Philosophie," p. 330.

View that preaxial (upper) border of pectoral limb is homologous with the same border of the pelvic limb. Wilder, B. G. 1872.1; Wyman, J. 1868.1.

Opposite view of reversed homologies, i.e., that preaxial border of pectoral is serially homologous with ventral border of pelvics. Braus, H. 1900.1 (p. 165).

Miscellaneous or unclassified papers relating to the origin of limbs. Eisler, P. 1895.1; Gill, T. N. 1898.2; Macdonald, W. 1840.1, 1872.1; Mehnert, E. H. 1897.1; Dollo, L. Add. 1896.1.

Branchial or gill arch hypothesis

This hypothesis of Gegenbaur holds that the paired fins have been derived from gill structures, the gill-arch having been modified into the limb-girdle, and the fin itself having been derived from the gill-septum. The position of the pelvic fins is attributed to their backward migration.

It considers a biserial appendage like that of Ceratodus (the Archipterygium) as the type from which all other fins and legs have been derived by a shortening of the axis and a loss of the pre-axial radials.

The principal papers in support of this hypothesis are ★Braus, H. 1899.2, 1900.1, **1906.1**; Davidoff, M. 1879.1; Fürbringer, M. 1902.1, 1903.1; ★Gegenbaur, C. **1864.2**, 1870.2,.4, 1873.1, **1876.1**, 1879.2, 1895.2; ★Klaatsch, H. **1896.1**.

Other papers of lesser importance are Bunge, A. 1874.1; Drüner, L. 1906.1; Emery, C. 1887.2, 1897.3; Jaekel, O. 1899.3,.4; Zalenskiĭ, V. V. 1898.1,.2.

The chief points made against this hypothesis by its opponents are summarized in Goodrich, E. S. 1906.1, *and in* Osburn, R. C. 1907.2.

Cell-accumulation hypothesis

This view of Geddes, the most recent of all, "does not in reality oppose the lateral fin hypothesis. Rather it expands it in one direction and refines it in another. It appears, too, to link together it and the modified gill-arch hypothesis."

Briefly, it holds that in every developing vertebrate there are five cell regions which are lines of potential cell-accumulation. At points where three regions meet, the tendency to cell-accumulation is especially marked. There are four such points and the cell-accumulations formed around them provided, far back in phylogeny, material capable of being selected to form the bases of new organs. At their commencement the limbs were, and still are, altogether independent of the cephalised axial part of the embryo, but later passed under its dominance.

For the full statement of this hypothesis, see ★Geddes, A. C. Add. **1912.1.**

External-gill hypothesis

This hypothesis of Kerr considers that the external gills were potentially motor and supporting structures and have given rise to limbs. The Gegenbaur view of the backward migration of the limbs is accepted together with his derivation of the limb girdle. The necessity of a skeletal axis in the external gill is provided for by Budgett's description of a rod of cartilage projecting into the external gill of the larval Polypterus.

For the original presentation of this view, see Kerr, J. G. 1900.2, 1901.2.

It has been further elaborated in ★Prof. Kerr's "Text-book of Embryology," 1919, vol. 2, pp. 449–453.

Lateral fin-fold hypothesis

This hypothesis was developed simultaneously by Balfour, Thacher, and Mivart. It is now the most generally accepted.

It holds that the paired fins are the persisting remains of a once continuous longitudinal fin-fold (essentially like that of the unpaired median fins) which stretched along each side of the body. In this, supporting radials or somactidia became developed as in the median fins and subsequently gave rise to the limb-girdles.

Original formulation of this hypothesis. Balfour, F. M. 1876.1, 1878.1, 1881.1; Mivart, St. G. J. 1878.1, 1879.1; Thacher, J. K. 1876.1.

The principal support for this hypothesis, from the evidence of comparative anatomy and embryology, is to be found in the papers of Dohrn, A. 1882.2 (vi), (ix); Harrison, R. G. 1895.2; Haswell, W. A. 1883.2; Mayer, P. 1886.1; ★Mollier, S. **1893.1**, 1895.1; ★Rabl, C. 1901.1, **1913.1**; Wiedersheim, R. E. 1886.2, **1892.1.**

Lesser papers supporting this hypothesis. ★Baur, G. H. 1885.1,.2, 1887.1,.2, 1888.1; Broom, R. 1913.3; Cope, E. D. 1890.1, 1892.6; Cunningham, J. T. 1884.1; Gregory, W. K. 1911.1,.2; Gregory, W. K. & Adams, L. A. 1914.1; ★Müller, E. 1909.1; Ryder, J. A. 1885.14, 1887.3; Thompson, D. W. 1886.1; Sauvage, H. E. Add. 1903.1.

Embryological evidence: the embryo of an ancient type of shark, Heterodontus (Ces-

Evolution — *Cont'd.*

tracion) japonicus "yields no evidence that there has ever been a migration of the fins in the Gegenbaurian sense." Dean, B. 1902.1. —*Further emphasis of these views.* ★Osburn, R. C. 1906.2–**1907.2.**

Palæontological evidence for the origin of the paired fins. *For a summary, see* ★Woodward, A. S. 1892.3.

The most primitive type of pectoral fin (in accordance with the fin-fold theory) is met with in the Devonian shark, Cladoselache. This type of fins was termed Ptychopterygium by Cope. For details see ★Dean, B. 1892.1, **1894.1,** 1896.1, 1902.2. — *Pectoral of Cladoselache considered to show no "ground for deriving the paired limbs from lateral folds."* Jaekel, O. 1892.3.

EYE

Comprising the structure of the organ of sight.

For the functions of the eye, *see under* Vision.

For the rotation or migration of the eye in flatfishes, *see under* Pleuronectidæ.

For Diseases of the eye, *see under* Pathology.

For all abnormalities affecting the eye including cyclopia, *see under* Teratology.

For accessory eyes or "augenähnliche Organe" of Leydig, Usov, et al, *see* Phosphorescent organs *under* Luminosity, etc.

Ophthalmoscopy and dioptrics of the fish eye. Beauregard, H. 1875.1; Hirschberg, J. 1882.1.

Observations on eyes of living Selachii. ★Franz, V. **1906.1.**

Size, relative to brain-weight (Sparidæ). Lapicque, L. 1908.1; Lapicque, L. & Laugier, H. 1908.1.

Anatomy and morphology. *General treatises.* Berger, E. 1882.1, 1883.1; Carrière, J. 1885.1; Friis, G. M. 1879.1; Virchow, H. 1882.1.

Miscellaneous and general. Am., Sc. 1879.1; Drummond, J. L. 1814.1; Fripp, H. E. 1866.1; Haller, A. 1762.1; Klingelhöffer, W. 1911.1; Leuckart, R. 1875.1; Rosenthal, F. 1811.2; Schiefferdecker, P. 1887.1; Ziegenhagen, P. 1895.1; Bates, W. H. Add. 1914.1; Fischer, von Waldheim, G. Add. 1830.1; Virchow, H. Add. 1881.1. — *Pre-Linn. refs.* Casserius, J. 1601.1; Derham, W. 1713.1; Dupetit, F. 1728.1.

Anatomy of eye of various fishes. *Amphioxus.* Nüsslin, O. 1877.1.

Cyclostomata, Bdellostoma, Myxine, and Petromyzon. Allen, B. M. 1902.1, 1905.1; Kohl, C. 1892.1; Langerhans, P. 1873.1; Možeyko, B. 1912.1; Retzius, M. G. 1893.1; Studnička, F. K. 1912.2.

Elasmobranchii. ★Franz, V. **1905.1;** Tiesing, B. 1895.1.

Ganoidei and Dipnoi (Protopterus). Denissenko, G. 1889.1; Grynfeltt, E. 1911.1; Hosch, - 1904.1.

Teleostei. Deichsel, G. 1908.1. — *Coryphæna.* Albers, J. A. Add. 1808.1. — *Boleophthalmus and Periophthalmus.* Baumeister, L. 1911.1, 1913.1; Klingelhöffer, W. 1912.1; Volz, W. 1905.2,.3. — *Gadus.* Deslongchamps, J. A. 1853.2; Albers, J. A. Add. 1806.1, 1808.1. — *Scomber.* Dyce, R. 1866.1; Massalien, F. C. 1815.1. — *Thynnus.* Faravelli, E. 1890.1; Jurine, L. 1821.1; Massalien, F. C. 1815.1; Moreau, E. 1872.1. — *Xiphias.* Grant, R. E. 1826.1; Lauber, - 1904.1; Ciaccio, G. V. Add. 1883.1. — *Carassius.* Hirsch, J. 1912.1. — *Silurus.* Matthiessen, H. F. 1886.1. — *Orthagoriscus.* Meek, A. 1904.4. — *Cyprinidæ.* Thilenius, G. 1892.1. — *Perca.* Wallace, W. C. 1835.1, *Pleuronectes.* 1834.2; — *Luvarus.* Berger, E. Add. 1881.1.

For the structure, etc., of the degenerate eyes of the blind fishes, chiefly Amblyopsidæ, see under Blind fishes of the caves. *See especially* Eigenmann, C. H. 1909.2.

For the highly modified eyes of abyssal fishes, see under Deep sea fishes. *For papers going into the subject most fully, see* Brauer, A. 1902.2,.3.

Anableps, the "four-eyed fish," a South American Poeciliid, has the eye divided by a horizontal constriction to permit vision both in the air and in the water. References are: M. C. Marsh in Evermann, B. W. & Goldsborough, E. L. 1902.3, p. 150; Klinckowström, A. 1893.1; Lacépède, B. G. 1799.2, Add. 1797.1; Schneider, J. G. 1803.1; Schneider von Orelli, M. 1908.1; Meckel, J. F. Add. 1818.1.

Development and embryology. *General accounts.* Desmoulins, L. A. 1823.1; ★Froriep, A. **1906.1;** Rathke, M. H. 1833.1; Schenk, S. L. 1867.1; Stockard, C. R. 1910.1; Waele, H. 1900.1. — *Dev. of telescopic eye, Goldfish.* Camuset, G. 1874.1.

Invagination of optic vesicle. Froriep, A. 1905.4; Locy, W. A. 1894.2,.3; Studnička, F. K. Add. 1913.1. — *Coloboma, persistence of the choroid fissure.* Bergmeister, O. 1875.1; Virchow, H. Add. 1900.1.

Development of circulatory system. Beauregard, H. 1876.1; Kittlitz, A. F. 1906.1; Virchow, H. 1890.1, Add. 1900.1.

Evolution, origin, and phylogeny. Dohrn, F. A. 1882.2(x); Froriep, A. 1906.2; Gaskell, W. H. 1898.1 (ix); Jelgersma, G. 1906.1; Müller, W. 1875.2; Parker, G. H. 1908.1; Metcalf, M. M. Add. 1906.1. — *Primitive organs of sight.* Beer, T. 1901.1. — *Origin in skin.* Bernard, H. M. 1897.1; Parker, G. H. 190[illegible].2. — *Phylogenetic significance of eye of Amphioxus.* Boveri, T. 1904.2. — *Significance of integumentary nerves for origin of eyes.* Parker, G. H. 1909.1,.2.

Histology, *in certain fishes.* — *Myctophum and Sternoptyx.* Brauer, A. 1904.3. — *Morrhua.* Cobbold, T. S. 1862.1, 1862.2. — *Selachii.* ★Franz, V. **1905.1.** — *Cephalopterus.* Mazza, F. 1889.1.

ACCESSORY PARTS OF EYE

Parts external to bulbus oculi

Ligamentum annulare, a structure lying in anterior chamber between cornea and iris. Ballowitz, E. 1913.5; Kolmer, W. 1913.1.

Relation of orbital wall to bulb. Harman, N. B. 1899.1.

Recessus orbitalis, an apparatus causing protrusion of the eye in Pleuronectidæ. Brown-Sequard, C. E. 1870.1; Holt, E. W. 1893.2; 1894.1.

Choroid gland. *Extra-retinal capillary blood-vessels surrounding optic nerve. Structure.* Brass, A. 1881.1; Cobbold, T. S. 1862.1,.2; Erdl, M. P. 1839.1; Müller, J. 1840.3,.4, Add. 1912.1.

Oculo-motor apparatus, *or muscles of the eye. Anatomy and morphology.* ★Allis, E. P. (*Mustelus*) **1901.1**; Couch, R. Q. 1851.2; Harman, N. B. 1899.1; Tiesing, B. 1895.1; ★Corning, H. K. Add. 1900.1.

Development. Dohrn, F. A. 1882.2 (xvi); Nussbaum, M. 1901.1; Lamb, A. B. (*Acanthias*) 1902.1.

Palpebral apparatus. *Morphology and development.* — *Nictitating membrane and muscles, Selachii.* ★Harman, N. B. **1899.1**; ★Ridewood, W. G. 1898.1; Rynberk, G. A. 1906.3. — *Eye-lids and fornix conjunctivæ, teleosts.* Hein, S. A. 1913.2.

Nictitating membrane of eyes of Selachii figured. Garman, S. 1913.1.

BULBUS OCULI

The eyeball and its parts

Choroid coat, *or vascular membrane of the eye.* — *Histology.* Grynfeltt, E. & Euzière, J. 1913.1. — *Tapetum lucidum, structure.* Blainville, H. M. 1822.1; Brücke, E. Add. 1845.1. — *Effect of light on tapetum.* Exner, S. & Januschke, H. 1905.1,.2; Januschke & Exner 1905.1.

Iris, the colored visible part of the choroid coat surrounding the pupil. Contraction and expansion through influence of light, temperature, etc. Bateson, W. 1890.1,.2; Brown-Séquard, C. E. 1859.1; Couch, J. 1866.5; Lieto-Vollaro, - 1908.1; Magnus, R. 1899.1; Müller, H. 1860.1, 1861.1; Reinhardt, J. C. 1837.1; Steinach, E. 1890.1; Guth, E. Add. 1901.1. — *Influence of colored lights.* Gysi, E. & Luchsinger, B. 1879.1.

Pupil, shapes of. Buchanan, H. 1822.1; Franz, V. 1906.1. — *Pupillary operculum (a projecting part of iris on dorsal edge of pupil helping to determine its shape).* Grynfeltt, E. & Demelle, A. 1908.1.

For the role of the falciform process of the choroid in vision, see Accommodation *under* Vision.

Crystalline lens. *Anatomical structure.* Brewster, D. 1816.1, 1831.1, 1833.1, 1836.1; Pflugk, A. 1909.1. — *Selachii.* Froriep, A. 1905.2. — *Petromyzon.* Gulliver, G. 1869.2. — *Anguilla.* Virchow, H. 1882.2. — *Aplanatism and periscopism.* Matthiessen, H. F. 1880.1, 1881.1. — *Early ref.* Leeuwenhoek, A. Pre-Linn. 1684.2, 1706.1.

Chemical composition. Payen, A. 1857.1; Valenciennes, A. & Fremy, E. 1854.3.

Histogenesis and development. Addario, C. 1902.3; Koranyi, A. 1886.1; Stockard, C. R. 1907.2, 1910.2,.3. — *Regeneration in teleosts.* Grochmalicki, J. 1908.1,.2,.3. — *Morphogenetic constitution, a thigmomorphic organ.* Mencl, E. 1903.1,.2,.4, 1908.1.

Retina. *Anatomical structure in various fishes.* Denissenko, G. 1882.1; Dogiel, A. S. 1883.1,.2; Gottsche, C. M. 1834.2; Heinemann, C. 1878.1; Hyrtl, C. J. 1861.1; Leydig, F. 1894.1; Retzius, M. G. 1896.1, Add. 1905.1; Schultze, M. J. 1871.1, 1872.1.

Development. ★Fürst, C. M. **1904.1**; Gunn, R. M. 1888.1; Kupffer, C. W. 1868.2.

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Visual purple; pigment of the rods. Abelsdorff, G. 1895.1, 1896.1; Abelsdorff, H. 1897.1; Bigelow, H. R. 1880.1. — *Two kinds, one in mammals, birds and amphibians, other violet-red in fishes.* Köttgen, E. & Abelsdorff, G. 1895.1.

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Membrana limitans. Addario, C. 1902.1; Retzius, M. G. 1904.1.

Vascularization of retina. Denissenko, G. 1880.1. — *Conger.* Grynfeltt, E. & Euzière, J. 1908.1. — *Anguilla.* Virchow, H. 1882.2.

Physiology of retina, experimental. — *Effects of light and darkness.* Chiarini, P. 1905.1, Add. 1904.1; Ricci, O. 1901.1.

Eye — *Cont'd.*
— *Effect of light.* Exner, S. & Januschke, H. 1906.1; Heger, P. 1896.1; Garten, S. Add. 1907.1; Gendersen Stort, A. G. Add. 1886.1, 1887.1. — *Effect of darkness.* Ogneff, J. F. 1910.1, 1911.1.

Sclera, *the sclerotic coat of the eye. Structure.* Langhans, T. 1865.1; Wedl, C. 1848.2.

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Vitreous humor. *Histogenesis.* Addario, C. 1902.2. — *Marsupium nigrum, a vascular structure in the vitreous.* Knox, R. 1824.2.

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FAUNA OF THE WORLD

Arranged by continents and thereunder chiefly under political divisions; enclosed or surrounding seas; contiguous islands, etc. If in doubt concerning the placement of a specific locality, see the index.

The status of political divisions is that existing during the period covered by this work, *i. e.* prior to the World War of 1914. Orthography, abbreviations and geographical arrangement follow the Century Atlas.

A map of the country concerned will be found convenient by the user of this section. For Deep-sea, Pelagic and Planktonic Faunas, *see* respectively under these items. For fossil fauna, *see* Palæontology. For sporting papers, *see under* Fisheries *and* Fishing methods.

ISLANDS

(Not placeable under continents)

Islands of South Atlantic Ocean

Ascension I. Günther, A. 1881.4; Nichols, J. T., & Murphy, R. C. 1917.1.—*Fernando Noronha I.* Boulenger, G. A. 1890.6. — *St. Helena I.* Clark, R. S. 1913.1; Cunningham, J. T. 1910.2; Günther, A. 1868.8, 1869.10; Martin, M. 1834.1; Melliss, J. C. 1875.1. — *South Georgia Is.* Fischer, J. G. 1885.1; Lönnberg, A. J. 1906.1. — *South Trinidad.* Nichols, J. T., & Murphy, R. C. 1914.1. — *Tristan da Cunha I.* Carmichael, D. 1817.1; Regan, C. T. 1913.8.

Islands of Indian Ocean

Mauritius, Réunion, Rodriguez, *etc., see* Indian Ocean Is. *under* Asia.

POLAR REGIONS

Antarctic Regions

General: ★Dollo, L. **1904.1.** — *Distribution of fishes.* ★Regan, C. T. **1914.1, 1916.3**; Roule, L. 1911.3. — *Supposed resemblance to fauna of Arctic regions.* Thompson, D. W. 1897.1. — *Various papers.* Boulenger, G. A. 1902.30, 1907.7; Chun, C. 1897.1 (*Plankton*); Dollo, L. 1900.1–.4, 1906.2–1907.1, 1908.1–1909.1,.3; Drygalski, E. 1904.1; G., J. W. 1906.1; Jacquinot, H., & Guichenot, A. 1853.1; Lönnberg, A. J. 1905.3,.6; Pappenheim, P. 1911.2, 1912.1, 1914.1; Pfeffer, G. J. 1890.2; Roule, L. 1913.2,.3; Roule, L., & Despax, R. 1911.1; Regan, C. T. 1913.1, 1914.1,.4, 1916.3; Vaillant, L. L. 1906.1–1906.3, 1907.1; Vanhöffen, E. 1901.1; Waite, E. R. 1909.2, 1911.3, 1916.2; Lampe, M. Add. 1914.1.

Kerguelen I.: Gill, T. N. 1876.1; Günther, A. 1879.3.

Arctic Regions

See also Alaska, Canada *and* Greenland *under* America, *and* Iceland *and* Spitzbergen *under* Europe.

General treatises: *lists, etc.* Bean, T. H. 1883.4; ★Ehrenbaum, E. **1901.2** *in* Römer, F., & Schaudinn, F. R. 1900.1; Jensen, A. S. 1905.1; Pennant, T. 1784.1–1792.1. — *Various papers, chiefly marine fauna.* Dewhurst, H. W. 1834.1; Gray, J. E. 1850.1; Grieg, J. A. 1896.1; Günther, A. 1877.1,.3,.8, 1878.2, 1881.2; Holmquist, O. 1899.1; Jensen, A. S. 1910.2; Knipovich, N. M. 1894.1, 1902.2, 1905.1; Peters, W. C. 1874.1; Phipps, C. J. 1774.1; Richardson, J. 1823.1, 1825.1, 1855.1, Add. 1836.1; Ross, J. C. 1826.1, 1828.1; Ross, J. 1835.1; Sabine, E. 1824.1,.2; Sabine, J. 1823.1; Scoresby, W. 1820.1. — *Distribution of animals available as food.* Petermann, A. H. 1852.1. — *Barents Sea.* Atkinson, G. T. 1908.1; Breitfuss, L. L. 1908.1; Breitfuss, L. L., Soldatov, V. K., & Göbel, J. 1908.1; Linko, A. 1907.1; Pietschmann, V. 1907.1. — *Bear I.* Malmgren, A. J. 1865.1. — *Kara Sea.* Lütken, C. F. 1887.1; Kerbert, C. Add. 1887.1. — *White Sea.* Khvorostansky, C. 1892.1; Knipovich, N. M. 1897.2, 1906.2,.3, 1907.2; Kuznetzov, I. D. 1908.2; Levander, K. M. 1888.1,.2.

Jan Mayen I.: Le Danois, E. 1913.3, 1914.1; Steindachner, F. 1886.1; Vaillant, L. 1894.1.

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Arrangement based upon Century Atlas of the World, 1913.

General treatise

Catalogue of the fresh-water fishes of Africa. ★Boulenger, G. A. Add. **1909.1**; (*List*) **1905.6.**

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With incidental references to the African fauna. Burchell, W. J. 1822.1; Dahl, K. 1897.1; Russegger, J. 1841.1,.2; Stanley, H. M. 1880.1, 1890.1.

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Algeria: *General.* Gervais, F. 1848.1, 1866.2, 1867.2, 1874.3; Guichenot, A. 1850.2; Werner, Franz. 1914.1. — *Works of travel.* Rozet, C. A. 1833.1; Scherer, J. 1905.1; Wilde, W. 1840.1. — *Fresh-water fauna.* Baird, S. F. 1871.20; Blanchard, R. 1903.1 (*Hamman-Meskhoutine*); Bounhiol, J. P. 1907.1; Duméril, A. H. 1858.3, 1863.1; Gervais, F. 1853.1; Günther, A. 1859.4 (*Tuggurt.*); Hult, R. 1895.1; Letourneux, A., & Playfair, R. L. 1871.1; Pellegrin, J. 1911.8; Raveret-Wattel, C. 1904.3; Rolland, G. F. 1881.1, 1895.1 (*Oued Rir*); Valenciennes, A. 1858.2. — *Marine fauna.* Bounhiol, J. P. 1908.1; Cépède, C. 1907.5; Pellegrin, J. 1913.3, 1914.2; Théry, A. 1909.1.

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Cape Verde Is.: *Chiefly marine.* Cardoso, J. 1895.1, 1900.1; Jenyns, L. 1842.1; Osorio, B. 1890.1, 1898.1, 1906.1; Troschel, F. H. 1866.1,.2.

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Niger River: *see also* Nigeria *and* Sudan.

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Molucca or Spice Is.: *Chiefly marine fauna.* Hubrecht, A. A. 1876.2; Schlegel, H., & Müller, S. 1839.3; Steindachner, F. 1903.1 — *Amboina I.*, see *below.* —*Banda Is.* Bleeker, P. 1851.2,.18, 1852.19, 1854.7, .8, 1856.12, 1859.8 —*Batjan I.* Bleeker, P. 1854.1, 1855.6,.15, 1856.14, 1857.20, 1859.27, 1860.7, 1862.8, 1863.19, 1868.12 —*Bouro I.* Bleeker, P. 1856.3, 1857.18, 1861.2, 1865.9 —*Ceram I.* Beaufort, L. F. 1912.1; Bleeker, P. 1852.6,.17, 1853.7, 1856.15, 1857.3, 1861.14, 1863.20, 1865.7 —*Gebi I.* Bleeker, P. 1868.13 —*Gilolo I.* Bleeker, P. 1853.15, 1854.3, 1855.17, 1863.33, 1867.3 —*Goram I.* Bleeker, P. 1858.2 — *Haruka I.* Bleeker, P. 1864.4, 1865.13, Add. 1866.1 — *Misol I.* Günther, A. 1872.10, 1873.8 — *Morotai I.* Bleeker, P. 1863.15 — *Nussalaut I.* Bleeker, P. 1864.8 —*Obi Major I.* Bleeker, P. 1855.5, 1863.8, 1868.18 —*Saparua I.* Bleeker, P. 1856.13, 1864.5 — *Ternate I.* Bleeker, P. 1853.3,.15, 1854.9, 1855.13,.20, 1856.16, 1857.1, 1862.4, 1863.9,.17, 1868.11; Meyer, A. B. 1885.1; Römer, F. 1896.1 — *Waigiu I.* Beaufort, L. F. 1912.1; Bleeker, P. 1868.6,.14. **Amboina I.**, *Chiefly marine fauna.* Bleeker, P. 1852.6,.16, 1853.6,.19, 1854.25, 1855.23, 1856.1, 1857.2, 1858.10, .11, 1859,38, 1860.6,.17,.19,.33, 1863.32, 1865.3,.6, 1866.4, 1868.6,.8, 1869.3,.5, 1871.1, 1873.7,.13; Boddaert, P. 1782.1; Boddaert, P., & Schlosser, J. A. 1768.1; Hornstedt, C. F. 1788.1; Peters, W. C. 1876.4; Semon, R. W. 1902.1; Weber, M. C. 1895.2 — Pre-Linn. *references to fauna of Amboina.* Prévost, A. F. 1747.1; Rumpf, G. E. 1705.1; Ruysch, H. 1718.2; Valentijn, F. 1724.1.

Natuna Is.: Bleeker, P. 1854.27.

New Guinea or Papua: *See also* Bismarck Archip. *Fresh-water fauna.* Perugia, A. 1894.1; Regan, C. T. 1908.7, 1914.8,.10; Weber, M. C. 1906.1, 1910.3, 1913.3; Hase, A. Add. 1914.1; Ogilby, J. D. Add. 1890.1, 1891,1, 1898.1 — *Possible former connection of New Guinea and Australia.* Weber, M. C. 1907.3, 1908.1. **Marine** *fauna, chiefly.* Alleyne, H. G., & Macleay, W. M. 1877.1;

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Bleeker, P. 1859.2, 1861.13, 1868.17, 1877.13, 1878.3, 1880.1; Boulenger, G. A. 1903.2; Jacquinot, H., & Guichenot, A. 1853.1; Macleay, W. 1877.2, 1883.1, 1884.2, Add. 1882.1,.2; Meyer, A. B. 1885.1; Ogilby, J. D., & McCulloch, A. R. 1916.1; Peters, W. C. 1876.4; Ramsay, E. P., & Ogilby, J. D. 1886.1; Regan, C. T. 1914.8; Weber, M. C. 1895.2, 1908.2 —*Works of travel and residence with incidental references.* Sonnerat, P. 1775.1, 1776.1, 1777.1; Albertis, L. M. Add. 1881.1; Clercq, F. S., & Schmeltz, J. Add. 1893.1; Forrest, T. Add. 1779.1; Krieger, M. Add. 1899.1.

Nias I.: Bleeker, P. 1856.4; Perugia, A. 1889.1.

Riou Linga Archip.: *Bintang I.* Bleeker, P. 1856.9, 1860.24, 1868.16 — *Riou I.* Bleeker, P. 1851.3, 1859.32.

Sangir Is.: Bleeker, P. 1857.5, 1868.10 — *Vernacular names.* Van Doren, J. B. Add. 1858.1.

Singapore I.: *Fresh-water fauna.* Bleeker, P. 1860.37; Castelnau, F. L. 1860.2 — *Marine fauna, chiefly.* Bedford, F. P. 1900.1; Bleeker, P. 1851.25, 1852.8, 1858.13, 1860.3,.9,.32,.37, 1861.6,.12, 1877.13; Filippi, F. 1867.1; Károli, J. 1882.1; Kner, R. 1864.4, 1865.3; Lütken, C. F. 1874.1; Steindachner, F. 1870.1; M'Clelland, J. Add. 1842.2.

Sulu Is.: *see under* Philippine Is.

Sumatra: *Catalogue.* ★Volz, W. **1907.1** —*Fresh-water fauna.* Bleeker, P. 1859.5,.6,.24; Boulenger, G. A. 1890.5; Volz, W. 1903.1, 1904.1,.2; Weber, M. C., & Beaufort, L. F. 1912.2; Hubrecht, A. A. Add. 1886.1 **Marine** *fauna, chiefly.* Bleeker, P. 1852.15, 1853.9,.16,.17, 1854.22, 1855.10,.22, 1858.1, 1859.5,.6,.13,.21,.23, .24,.30,.31, 1860.1,.8,.30,.34, 1861.8; Brauer, A. 1902.1; ★Fowler, H. W. **1904.1**; Park, M. 1797.1; Perugia, A. 1889.1, 1893.1; Vinciguerra, D. 1879.1; Volz, W. 1903.1, 1904.1,.2.

Sunda Is.: *See also* Java, *and* Sumatra. Schlegel, H., & Müller, S. 1839.3 —*Bali I.* Bleeker, P. 1849.2, 1857.12, 1859.4, 1860.22, 1861.10 —*Batu Is.* Bleeker, P. 1855.4,.16, 1857.8 —*Engano I.* Perugia, A. 1893.2 — *Kokos I.* Bleeker, P. 1854.21 —*Lombok I.* Popta, C. M. 1911.2, 1912.4 — *Madura I.* Bleeker, P. 1849.3 — *Mentawi Is.* Perugia, A. 1896.2 — *Rotti I.* Bleeker, P. 1863.24; Reuvens, C. L. 1895.2 — *Sandalwood (Sumba), and Semao Is.* Reuvens, C. L. 1895.2 —*Solor I.* Bleeker, P. 1851.24, 1852.20, 1853.2, 1854.10, 1868.1, Add. 1854.1 —*Sumbawa I.* Bleeker, P. 1848.1, 1855.12, Add. 1859.1.

Timor I.: Bleeker, P. 1852.9, 1854.18, 1857.20, 1860.18, 1861.15, 1863.21; Reuvens, C. L. 1895.2; Weber, M. C., & Beaufort, L. F. 1912.3.

Woodlark *or Moiou I.:* Montrouzier, X. 1856.1–1857.1; Thiollière, V. J. 1856.1

MELANESIA

Bismarck Archip.: *Neu Pommern. (New Britain)* De Vis, C. W. 1884.2; Günther, A. 1877.5 — *New Hanover.* Peters, W. C. 1876.4 — *New Mecklenburg, (New Ireland)* Günther, A. 1877.5; Peters, W. C. 1876.4.

New Caledonia: Forster, J. R. 1844.1; Garnier, J. 1903.1; Jouan, H. 1861.1, 1878.1; Ogilby, J. D. 1898.1; Weber, M. C., & Beaufort, L. F. 1913.1.

New Hebrides: De Vis, C. W. 1884.2; Pellegrin, J. 1912.15; Regan, C. T. 1904.1; Seale, A. 1906.1.

Solomon Is.: Macleay, W. 1880.1; Ogilby, J. D. 1890.5; Seale, A. 1906.1.

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Caroline Is.: Fowler, H. W. 1900.4, 1902.2; Jacquinot, H., & Guichenot, A. 1853.1; Kittlitz, F. H. 1858.1; Vaillant, L. L. 1893.6 — *Work of travel.* Christian, F. W. Add. 1899.1.

Johnston I.: Smith, R., & Swain, J. 1882.1.

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Cook Is.: Kendall, W. C., & Goldsborough, E. L. 1911.1 — *Rarotonga.* Seale, A. 1906.1 — *Aitutaki I. (Sport)* Anon. 280.

Easter I. Kendall, W., & Radcliffe, L. 1912.1; Regan, C. T. 1913.3.

Ellice Is.: *Funafuti.* Waite, E. R. 1897.1, 1899.1.

Fanning Is.: Streets, T. H. 1878.1.

Fiji Is.: Boulenger, G. A. 1897.7 (*Rotumah*); Garman, S. 1903.1; Jacquinot, H., & Guichenot, A. 1853.1; Jordan, D. S., & Dickerson, M. C. 1908.3; Peters, W. C. 1876.4 — *Viti Levu.* Macdonald, J. D. 1869.1; Steindachner, F., & Kner, R. 1870.1.

Gilbert Is.: Kittlitz, F. H. 1858.1; Krämer, A. 1901.1; Waite, E. R. 1903.3.

Low Archip. or Paumota Is.: *Mangareva Is.* Kendall, W. C., & Radcliffe, L. 1912.1 — *Makatea.* Seale, A. 1906.1 — *Marutea and Rikitea.* Vaillant, L. L. 1887.2 — *King's I. (Fresh-water)* Johnston, R. M. Add. 1887.1.

Marquesas Is.: *Nukahiva.* Seale, A. 1906.1 — *Works of travel.* Christian, F. W. Add. 1910.1; Coulter, J. Add. 1845.1.

Samoan Is.: *General treatise.* ★Jordan, D. S. & Seale, A. **1906.2** — *Various papers, chiefly marine fauna.* Evermann,

B. W. 1902.7; Fowler, H. W. 1901.1; Jordan, D. S. 1902.7; Kendall, W. C., & Radcliffe, L. 1912.1; Steindachner, F. 1901.1, 1906.4; Streets, T. H. 1878.1.

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Suvarof I.: Stead, D. G. 1907.4.

Tonga Is.: (*Friendly Is.*) Kendall, W. C., & Goldsborough, E. L. 1911.1.

Tubuai *or Austral Is.:* Seale, A. 1906.1.

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South or Middle I.: (*Marine fauna*) *Dunedin.* Parker, T. J. 1884.3; Thomson, P. 1877.1, 1879.1; Webb, J. S. 1873.1 — *Hawkes Bay, Napier.* H., A. 1883.1; Hamilton, A. 1886.1 — *Hokitika.* Campbell, W. D. 1879.1; Clarke, F. E. 1879.1 — *Moeraki.* Parker, T. J. 1884.2, 1887.2 — *Nelson Harbor.* Hector, J. 1882.1; Kingsley, R. I. 1889.1 — *Otago.* Thomson, G. M. 1913.1 — *Poverty Bay.* Williams, W. L. 1893.1.

Campbell I.: Sauvage, H. E. 1880.6.

Kermadec Is.: *List and comparison with Lord Howe I.* Waite, E. R. 1910.1, 1911.1.

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FINS (*LIMBS OF FISHES*)

Many of the papers cited here include the musculature of the fins. Other papers more specifically relating to musculature will be found *below* Limb and trunk muscles *under* Myology.

For the structure of the limb girdles, *see under* Pectoral girdle, *and* Pelvic girdle.

For the renewal of the dermal rays and the fin-membranes after their removal, *see under* Regeneration.

For all references to abnormalities in the structure of fins, such as the absence in some individuals of certain fins, or the presence of extra, accessory, or supernumerary fins, *see below* Abnormalities of fins *under* Teratology.

For the functions of the fins, *see under* Locomotion.

Morphologically, the limbs of fishes may be divided into the median and the paired fins.

SUPPORTING ELEMENTS

Endoskeletal fin-supports

Both the median and paired fins are supported by an internal skeleton composed of cartilaginous or bony *endoskeletal* pieces, the radial elements (or pterygiophores of Parker, T. J. 1886.3, p. 24). These provide supports for the *exoskeletal* dermal fin-rays which are described below.

The essential distinction between the endoskeletal fin-supports and the secondary exoskeletal dermal rays was first brought out by Bruch (C. W. 1861.1).

In the Cyclostomata, presumably representing the primitive condition, the radial elements are unsegmented outgrowths from the dorsal and ventral vertebral arches, *i. e.* extensions of the neural and hæmal spines. In the Dipnoi, the mesial supporting elements are also prolonged neural and hæmal spines, each being subdivided into three segments. Likewise in Pleuracanthus, according to Woodward (A. S. 1892.3), the identity in origin of the endoskeletal fin-supports and the processes of the vertebræ is well shown.

Fins — *Cont'd.*

In Cladoselache, a primitive Elasmobranch, the radial elements have become divided into a basal and a distal segment (Dean, B. 1894.1). In existing Elasmobranchs, the elements are generally trisegmental. While generally trisegmental in the Teleostomes, they here exhibit a tendency toward reduction, and their original relations to the vertebral arches are obscured. They are, in Teleosts, generally called "interspinous bones" (interneural or interhæmal elements).

The series of endoskeletal fin-supports, following the arrangement of Bridge (p. 533), may be termed *radial elements*. They may be further subdivided into *proximal* (basal or innermost), *mesial*, and *distal segments*. When bisegmental, the terms "basal" and "radial" (Dean, B. 1895.4, p. 32) have often been employed. The terms of Cope (E. D. 1890.1, p. 414); *axonost* equivalent to "proximal", and *baseost*, supporting the dermal fin-rays, and equivalent to "mesial" or "distal," although adopted by Woodward (A. S. 1889.2, vol. ii, p. 321) seem unnecessary.

The most valuable summary of this subject (in Ganoids and Teleosts), is ★Bridge, T. W. **1896.1.**

In Elasmobranchs, Mivart termed these elements "radials" (further subdivided into basal or innermost, median, and distal cartilages). Excellent descriptions with figures of numerous species are given in Mivart, St. G. 1879.1.

Thacher (p. 292), *noting that the fin-supports of Dipnoi are elongated neural spines, believed that this condition, instead of being primitive, was due to the loss of the "primordial median fin-rays" (radials).* Thacher, J. K. 1876.1.

Development of dermal fin-rays

The following remarks present a summary of Goodrich, E. S. 1904.1.

In all of the fins of the true Pisces, there are dermal (*exoskeletal*) rays of mesoblastic origin, the *dermotrichia*. In Amphioxus and the Cyclostomata, however, true dermal rays are not developed. The ray-like structures which have been described in the larva of Amphioxus are merely elongated epidermal cells. The delicate cartilaginous rays supporting the fins of Cyclostomes are endoskeletal, being prolongations of the neural and hæmal arches.

In the Elasmobranchii and Holocephali, probably also the Acanthodii and Ichthyotomi, there is a *single* type of dermal ray, the *ceratotrichia* (Goodrich's term, p. 469), known also as "Hornfäden" or "Elastoidinfäden" by German authors. These fibrous, flexible, *horny* rays are never ossified nor jointed, but may be branched. The fibrils are secreted by the mesoblastic scleroblasts. Sections of the fin may show several layers of ceratotrichia on either side. The dermal or placoid (shagreen) denticles are quite independent of these rays and are more superficial in position, generally concealing them from view.

In the Teleostomes, occur *two* types of dermal rays. The first of these, slender, unjointed, horny fin-rays, essentially like and possibly identical with the ceratotrichia, were first noted in the adipose fin of Salmonidæ by La Valette St. George (A. J. 1880.2). By Ryder (J. A. 1885.6, p. 157) they were named *actinotrichia*. They are the earliest rays in the embryonic fins, being later functionally replaced by the following type, except in the adipose fin and in the growing fin-edges, where they persist. The definitive *bony* fin-rays, typically ossified, jointed, and branched, are termed *lepidotrichia* by Goodrich, p. 472. The essential resemblance of these rays to the body-scales was noted by Baudelot (E. 1873.3), and this homology was clearly established by Hertwig (O. 1876.1). A perfect transition between the scales and the joints of the lepidotrichia in the fossil Amblypterus is shown by Goodrich (fig. 55). Formed bilaterally, and later fused, each dermal ray is double. Each ray articulates with the extremity of one endoskeletal fin support (radial element) in the higher Teleostomes, but in the lower Teleostomes and Dipnoi the dermal rays are more numerous.

In the Dipnoi, there are jointed, branched, dermal rays, containing bone-cells, which Goodrich (p. 513) calls *camptotrichia*. These seem to be in a degenerate condition and may represent the lepidotrichia of the Teleostomes. As in certain Teleosts, scales may extend over the greater part of the fins, and thus secondarily overlie the dermal rays.

As above indicated, the most valuable paper on this subject is ★Goodrich, E. S. **1904.1.**

Scholarly treatises on the development of the horny rays of Elasmobranchs and the bony rays of Teleosts are cited under ★Harrison, R. G. 1893.1–1895.2.

Development or structure of the fin-rays in various fishes. ★Brohl, E. 1909.1; Hancock, J. 1830.2; ★Ryder, J. A. 1879.1, 1887.5, 1890.1; Szily, A. 1907.1; Vaillant, L. L. 1896.5; Ziegler, H. E. 1908.3.

"Very thin, structureless" fin-rays in the adipose fin (of Osmerus) were first noted in a brief remark by Gulliver, G. 1872.2.

The distinction between fin-rays as exoskeletal *from other bones as* endoskeletal *breaks down on embryological grounds, since both are of* mesoblastic *origin, according to* Ryder, J. A. 1885.2.

Relation of temperature to the number of fin-rays in Pleuronectidæ (reduction in warmer climates). Cox, P. Add. 1903.1.

Development of fin spines

In Elasmobranchs the secondary clustering of the dermal denticles or cusps on the exposed anterior fin margins (Dean, B. 1895.4, p. 28) has produced rigid spines or dermal defenses.

In Teleostomes the development of bony tissue in the anterior dermal fin rays also produces stout spines. While the soft dermal rays exist in all Teleostomes, spines, followed by soft rays, occur only in more specialized forms, which form the old order of *Acanthopterygii.*

Structure and development of the spines in Elasmobranchs. Hannover, A. 1868.1; ★Koppen, H. 1901.1; Meyer, G. H. 1847.1; ★Markert, F. 1896.1; ★Ritter, P. 1900.1.

Structure or development in the following Teleosts. — Siluridæ. Bliss, R. 1875.1. — *Gasterosteus.* Ryder, J. A. 1885.3. — *Synodontis.* Vaillant, L. L. 1895.2, 1898.2.

Articulation of spines in Teleosts, including the trigger mechanism for locking the spines and the musculature for their erection. Bliss, R. (*Balistes*) 1872.2; Dönitz, F. K. (*Teuthis*) 1866.1, 1867.2; Hilgendorf, F. M. (*Monocentris*) 1879.3; Mayer, A. F. 1862.1; Sørenson, W. E. 1884.1, 1897.1; ★Thilo, O. 1879.1–1898.1, .3, 1901.1, Add. 1899.1–1910.1.

Numerous species of Teleosts have a "Poison apparatus composed of spines and associated glands." *For references, see below this caption under* Poisonous fishes.

Ichthyodorulites. Numerous isolated spines, found in the Devonian and Carboniferous strata, are considered to be the dorsal spines of Elasmobranchs. They constitute the sole remains of these fishes. Their nature was first recognized by Buckland and De la Beche who used the term "ichthyodorulites." By Woodward (p. 92), this term is restricted to those spines, tubercles, and plates exhibiting the microscopical structure of vascular dentine. Numerous genera have been proposed for these isolated spines.

Full bibliographic references to all genera will be found in Woodward's "Catalogue" (Woodward, A. S. 1889.2, vol. ii, p. 92 *et seq.*) and (American forms) in Hay, O. P. 1902.1, p. 326.

MEDIAN FINS

Including the dorsal, caudal, and anal fins. The median fins are believed to be of greater antiquity than the paired fins. In embryo fishes, a continuous median fringe appears long before the origin of the paired fins. In the lower groups, Cephalochordata and Cyclostomata, the median fins are the only existing fins, although this condition may be due to the loss of the paired fins through degeneration.

The median fins are considered to be the discontinuous remnants of a primitively continuous median fringe.

A valuable work in German, especially on the embryological development of the median fins, is ★Schmalhausen, J. J. **1912.1.**

See also ★Goodrich, E. S. 1906.1, *who showed that the median fins in Elasmobranchs develop essentially like the paired fins.*

Through artificial breeding, the Japanese have produced numerous modifications in the median fins of goldfish; there are double-tailed varieties, split or double anal fins, etc., etc. See Bade, E. 1905.2; Matsubara, S. 1908.1; Pouchet, G. 1870.1; ★Smith, H. M. 1909.2; ★Storch, O. 1911.1; *and* Watase, S. 1887.1.

In Echeneis and Remora, the dorsal fin has become greatly modified to form an Adhesive disk, *which see.*

Morphology and development of median fins chiefly the caudal fin or tail

Most of the following references, except as otherwise stated, treat of the morphological nature of the termination of the vertebral column in the tail. This work has been in gradual expansion and more precise definition of the original conception of Agassiz (J. L. 1833.2), who on the grounds of *external* symmetry recognized two types of caudal fin, the *asymmetrical* "heterocercal" and the *symmetrical* "homocercal" types.

The most recent and valuable summaries of this subject, from which most of the information given below has been gleaned, are those cited under ★Whitehouse, R. H. **1910.1** *and* **1910.2**.

An older but valuable, complete discussion of the subject is ★Ryder, J. A. **1886.8.**

Other papers with further delimitations and refinements in terminology are ★Dollo, L. 1896.2 *and* ★Gregory, W. K. 1907.1.

Hippocampus lacking a caudal fin uses tail as a prehensile organ. Dufossé, A. 1874.2.

TYPES OF CAUDAL FINS

Protocercy. All fishes first possess a protocercal tail in the embryonic condition, and it seems safe to infer that this is the true primitive condition, from which the more specialized types have evolved. A *protocercal* fin may be defined as one which is *primitively symmetrical*, externally and internally, having not undergone any reduction or modification of the original form. The chorda ends in a perfectly straight line and the supports of the fin-rays are *equal* in number and kind, both dorsally and ventrally, so that the dorsal and ventral fin-rays contributing to the caudal fin are likewise equal in number and position. The term "protocercal" was first used by Wyman (J. 1864.2) to designate the median fin-fold condition of the tail of the larval Raja. Agassiz (A. 1878.1, I, p. 123) proposed the term *leptocardial* which is now considered synonymous with the preceding.

Another type of caudal fin, also perfectly symmetrical both internally and externally, which however is *secondarily symmetrical*, is the *gephyrocercal* type defined below.

M'Coy (Sir F. 1848.2, p. 304) first used the term *diphycercal* to designate the *symmetrical* caudal fin of Diplopterus. Cope (E. D. 1871.1, p. 452) in ignorance of this term, coined *isocercal* for the symmetrical caudal. The term "diphycercal" originally used with no qualification regarding primitive or secondary symmetry, may, for all practical purposes, be dismissed, in the view of Whitehouse, who would however retain it "as applying to a caudal fin which it may not be wise or possible to refer to as protocercal or gephyrocercal."

"It is probably correct to say that no true fishes possess a protocercal fin in the adult condition; the Cyclostomes are generally credited with having protocercal tails, but it is likely that even here a degenerate condition is present." Whitehouse, R. H. 1910.1, p. 135.

Median fins of Cyclostomata

For the caudal skeleton in Myxine and Petromyzon, see ★Ayers, H. & Jackson, C. M. 1900.1; Cleland, J. 1886.1; Retzius, M. G. 1892.1, 1895.2; ★Schaffer, J. 1901.1,.2.

The "pre-anal fin" of Myxine is a skin fold, according to Lönnberg, A. J. 1902.7.

Heterocercy. "A *heterocercal* caudal fin may be defined as one in which the extremity of the chorda is directed upwards, and as a consequence is *unsymmetrical* externally and internally, the ventral lobe being greater than the dorsal; and, moreover — and this is a most important feature, to which I have not seen attention drawn — when centra are formed, these elements remain distinct to the end of the axis." Whitehouse, R. H. 1910.1, p. 136.

Heterocercy in Elasmobranchii

Chiefly, development and morphology of the tail in Selachians. Ahlborn, C. G., 1895.2; Beneden, P. J. 1853.1, 1861.1; ★Dohrn, A. 1882.2 (vi); Garman, S. (*Chlamydoselachus*) 1887.1; Haswell, W. A. 1885.2; Helbing, H. 1902.1, 1904.1; ★Mayer, P. **1886.1**; Virchow, H. 1895.3; ★Schmalhausen, J. Add. 1913.1.

Fins — *Cont'd.*

Excellent plates of the skeleton of the median fins of many Selachians appear in ★Mivart, St. G. 1879.1.

Heterocercy in Teleostomi

"In *Acipenser* the typical heterocercal form . . . is present; *Polydon* by an increase in the size of the ventral lobe reaches a step towards the externally symmetrical homocercal fin; while *Amia* proceeds furthest of all in the homocercal direction, requiring but one single feature, the possession of a true urostyle, to attain the homocercal condition." Whitehouse, R. H. 1910.2 (p. 595, 596).

Development of median fins, especially the dorsal fin, in Acipenser. Dikson, B. 1912.1; ★Zalenskiĭ, V. V. 1899.1; Zograf, N. Y. 1887.3; Schmalhausen, J. J. Add. 1913.1.

Development of tail, respectively in Lepidosteus and Amia. Wilder, B. G. 1876.2, 1877.6.

General accounts of the tail of Teleostomes, including Ganoids, are Heckel, J. J. 1850.3, *and* Kölliker, R. A. Add. 1860.1.

Homocercy. With the possible exception of the forms mentioned below under "gephyrocercy," this form of caudal is found in all Teleostei. It may be considered a specialized form of the heterocercal type. The term "homocercal" is very broad in application. By Whitehouse (R. H. 1910.1, p. 138), it is defined as "a caudal fin which is externally symmetrical but in which the majority of the fin-rays are supported internally by hypaxial [ventral] elements, and in which a urostyle is present either in the adult or at some time during larval history."

The most comprehensive account of the morphology of the tail in Teleostei is ★Whitehouse, R. H. **1910.2**.

Huxley (T. H. 1859.1) *says that "the first accurate and comprehensive account of the structure of the piscine tail," is* ★Heckel, J. J. 1850.3.

Other papers on the morphology or development of the caudal in Teleosts, are ★Agassiz, A. 1878.1; Baudelot, E. 1868.2; Costa, A. 1869.1; ★Huxley, T. H. 1859.1; ★Lotz, T. 1864.1; Peach, C. W. 1859.2; Regan, C. T. 1910.2,.5; ★Ryder, J. A. 1885.11,.14, 1886.8; Sauvage, H. E. 1872.1; Schmidt, V. 1893.1; Steenstrup, J. J. 1866.1; ★Totton, A. K. (*Pleuragramma*) 1914.1; ★Kölliker, R. A. Add. **1860.1**; Newton, E. T. Add. 1882.1.

Gephyrocercy. The *gephyrocercal* caudal is a *secondary* one, the original caudal being aborted or lost during larval (Mola) or postlarval existence (Fierasfer), and the secondary fin formed by the union of the rays of the dorsal and ventral median fins, around the abbreviated extremity. It is perfectly *symmetrical*, both externally and internally. The term "secondary diphycercy," as above stated, is synonymous with this term.

As stated in the original definition (Ryder, J. A. 1886.8, p. 991), among Teleosts, this type of caudal occurs only in the two forms, Mola and Fierasfer.

Certain fossil forms of Cœlacanthidæ (Crossopterygii), such as Undina, possess a gephyrocercal caudal fin (Reis, O. M. 1888.1, 1892.3).

Gephyrocercy in Dipnoi

"It is highly probable that this group will be found to afford the best examples of the gephyrocercal form." Whitehouse, R. H. 1910.1, p. 142.

"Diphycercy in its existing conditions, . . . as in Ceratodus, is, . . . a specialized, perhaps more strictly a degenerate condition, directly comparable with gephyrocercy." Dean, B. 1894.1, p. 102.

Dollo (L. 1896.2) in the "phylogénie des dipneustes" has erred in too extensive an application of the term "gephyrocercy," in the belief of Whitehouse.

PAIRED FINS

Including the pectoral, and the pelvic or ventral fins. The following references are arranged primarily with regard to the anatomical structure in the different groups. However, most of such researches have been inspired by the views of the derivation or origin of the paired fins. The latter topic forms a separate subject and the chief hypotheses on the origin of the limbs are discussed *below* "Phylogenesis of limbs" *under* Evolution.

The hypothesis of the origin of the paired fins from a continuous lateral fin-fold, like that of the median fins, is now the most prevalent view. It was the independent observation by both Mivart and Thacher, of the resemblance between the median and paired fin-structures in Raja, which led each separately to form his conception of the identity in origin of the median and paired fins (Mivart, St. G. 1879.1, p. 467).

General treatises

Valuable general treatises in German, treating of the development and structure of the paired fins in all groups, are ★Braus, H. 1904.2, **1906.1**; ★Davidoff, M. 1879.1; ★Gegenbaur, C. 1864.2 (ii); *and* ★Wiedersheim, R. **1892.1**.

Valuable treatises in English, especially reviewing the origin of the paired fins, are ★Goodrich, E. S. **1906.1** *and* ★Mivart, St. G. 1879.1.

Various miscellaneous or unclassified papers on the paired fins are Geoffroy-Saint-Hilaire, E. F. 1807.3,.4,.7, 1818.2,.4; Gouriet, E. 1868.1; Hartwig, P. 1870.1; Hatschek, B. 1889.1; ★Kner, R. 1860.2; Lavocat, A. 1896.1; Mettenheimer, C. F. 1847.1.

Paired fins in the various groups

Fins of Dipnoi

Gegenbaur (C. 1870.4) originally adopted the Lepidosiren type of limb as the ancestral form of the Elasmobranch fin. He later (1873.1) adopted the Ceratodus type as the archipterygium or the fundamental form of the vertebrate limb. This view was accepted by Günther (A. C. 1871.4) and by Huxley (T. H. 1876.1).

A contrary view was formulated by Mivart (St. G. 1879.1, p. 473) who says "the fin of Ceratodus cannot represent the archipterygium, and, far from being a primitive form . . ., is, on the contrary, a very special and peculiar structure, which is carried to a still more abnormal development in Lepidosiren, by progressive elongation and by atrophy of the postaxial radials."

Howes (G. B. 1887.1, p. 24) believes "that the paired fins of Plagiostomes and Dipnoi have, in all probability, arisen independently from a type of fin most nearly represented by that of the living chimæroids."

Embryological development of paired fins in —Lepidosiren and Protopterus. Agar, W. E. 1907.1. —*Ceratodus* (*Neoceratodus*) ★Semon, R. W. **1898.1,** 1899.3.

Musculature and innervation of the fins of Ceratodus. Braus, H. 1898.1, 1900.1.

Skeleton of the paired fins, chiefly of Ceratodus. ★Davidoff, M. 1879.1; Haswell, W. A. 1883.2; ★Howes, G. B. 1887.1; Sabatier, C. P. 1904.1; Schneider, A. F. 1886.1, 1887.1; Vanhöffen, E. 1890.1.

Fins of Elasmobranchii

As described by Balfour (F. M. 1881.1, p. 663), the skeleton of the pectoral fin of Elasmobranchs "consists of three basal pieces [radials] articulating with the pectoral girdle; on the outer side of which there is a series of more or less segmented cartilaginous fin-rays [also radials]. Of the basal cartilages one is anterior [external], a second is placed in the middle, and a third is posterior [internal]. They have been named by Gegenbaur the *propterygium*, the *mesopterygium*, and the *metapterygium;* and these names are now generally adopted."

Embryological development of the paired fins in Selachii, including the development of the skeleton. Balfour, F. M. 1881.1; Braus, H. 1906.2; Dohrn, A. 1882.2 (vi); Goodrich, E. S. 1906.1; Ruge, E. (*Spinax*) 1902.1; Mollier, S. Add. 1892.1.

Musculature, innervation, etc., of the paired fins. ★Braus, H. 1898.1,.2, 1899.1, 1906.2; ★Backman, G. **1913.1**; ★Müller, E. **1909.1, 1911.1.**

Structure and arrangement of the skeletal elements of the paired fins. Gegenbaur, C. 1870.4; ★Haswell, W. A. 1885.2; Helbing, H. 1902.1, 1904.1; Howes, G. B. 1890.1; ★Mivart, St. G. 1878.1, 1879.1; Prince, E. E. & MacKay, A. H. (*Lamna*) 1901.1; Sabatier, C. P. 1898.1, 1904.1.

Pectoral fin skeleton in various fossil sharks. Braus, H. 1902.1; Fritsch, A. J. (*Pleuracanthus*) 1888.2–1891.1.

See also Phylogenesis of Limbs *under* Evolution.

Numerous examples have been recorded of abnormal rays or skates in which the pectorals are not adherent to the head. This teratological form was described as the new genus Propterygia, by Otto (A. W. 1821.2). *For these references, see under* Teratology.

For the appendages of the pelvic fins of male Elasmobranchs (Myxopterygia), *see* Copulatory organs *below* Viviparity *under* Reproduction.

Fins of Teleostomi

Crossopterygii

Skeleton of the paired fins of Crossopterygii. Emery, C. 1897.3; ★Gegenbaur, C. 1895.2; ★Klaatsch, H. **1896.1.**

Variation in skeleton of pectoral, in Polypterus. Bamford, E. E. 1913.1.

Pelvic fin of Eusthenopteron. Goodrich, E. S. 1901.1. — *Pectoral of Cœlacanthus.* Wellburn, E. D. 1901.4.

Chondrostei and Holostei

Development of skeleton of pectoral fins in Amia. Heronimus, C. 1911.1.

Embryological development of paired fins in Acipenser. ★Mollier, S. 1893.1.

Figures of the skeleton of the pelvic fin — Acipenser, Polydon, and Scaphirhynchus. Rautenfeld, E. 1882.1. — *Polydon.* Thacher, J. K. 1877.1.

Teleostei

Embryological development of the paired fins in Teleosts, chiefly the trout or salmon, including the development of the fin skeleton and the girdles. ★Boyer, E. R. 1892.1; Corning, H. K. 1894.1; Derjugin, K. M. 1908.1–1912.1; Ducret, E. 1893.1, 1894.1; ★Harrison, R. G. 1894.1, 1895.2; Oellacher, J. 1872.1, 1879.1; Prince, E. E. 1886.3, 1890.2; Swinnerton, H. H. 1905.1,.2; Swirski, G. (*Esox*) 1880.1; ★Vogel, R. **1909.1.**

Development of the large pectorals in the flying-fish, Exocœtus. Derjugin, K. M. 1908.1; Derjugin, K. & Rozhdestvensky, E. 1912.1.

The larval Symbranchus, for a while, has large pectorals which later disappear. Derjugin, K. M. 1912.1; Taylor, M. 1913.1.

The larval sole (*Achirus*) *likewise possesses pectoral fins which disappear when it is half-grown.* Putnam, F. W. 1865.8, 1866.5.

The young of Onus mustela have greatly developed paired fins, which in the adult are less in proportion. Paul, D. M. 1902.2.

Sexual dimorphism in development of pectoral fins in Phoxinus. Fatio, V. 1875.1.

In Lophius, during development, there is a sudden forward translocation of the pelvic fins. Ryder, J. A. 1885.13.

Morphology of the paired fins, including their attachment to the girdles, innervation, skeleton, etc. Belling, D. E. 1911.1; Bruch, C. W. 1861.1; Hamburger, R. 1904.1; Hammarsten, O. D. 1911.1; Koltzoff, N. K. 1896.1; Nordenson, J. W. 1910.1; ★Pychlau, W. 1908.1; Rautenfeld, E. 1882.1.

The so-called "adipose lobe" of the pelvic fin of Salmo is an enlarged scale according to Shann, E. W. 1913.1.

The pectorals of Periophthalmus are modified to permit of overland locomotion. For their structural modifications, musculature, etc. see Hämmerle, L. 1897.1 *and* Hamburger, R. 1904.1.

The Gurnards (*Triglidæ*) *have finger-like* (*dactyloid or digitiform*) *appendages or filaments at the anterior margin of the pectoral fin by which they feel the bottom in search of their food. The following papers refer to these structures, chiefly in Prionotus and Trigla.* Allen, H. 1886.1; Belling, D. E. 1911.1; Deslongchamps, J. A. 1843.1; Evant, T. 1903.1,.2; Hamburger, R. 1904.1; Jourdain, S. 1870.1; ★Morrill, A. D. 1895.1; Tiedemann, D. F. 1816.2.

In some genera of Cyclopteridæ (*Cyclopterus and Liparis*) *and Gobiesocidæ* (*Lepadogaster*), *the pelvic fins have coalesced to form a sucking disk. See* Adhesive disk.

FISHERIES OF THE WORLD

For topics intimately related to the subject of fisheries, but dealing more specifically with the cultivation and propagation of fishes, *see under* Pisciculture. *For* general works relating to food fishes of various regions, *see the section* Fauna of the World.

It should be obvious that statements herein as to the constitution and activities of governmental departments, the International Commission for the Investigation of the Sea, etc., apply to pre-war conditions.

An excellent analysis of the publications of the U. S. Bureau of Fisheries has just appeared (April, 1921), too late, however, for more than incidental use in the preparation of this section. This catalogue, by Miss Rose M. E. MacDonald, is entitled "*An Analytical Subject Bibliography* . . . 1871–1920," and is published as *Appendix V* to the *Rept. U. S. Comm. Fish.*, 1920.

Treating relatively a much smaller number of papers than are comprised in the present bibliography, a plan is possible having advantages over our necessarily condensed arrangement. It should be consulted by the serious student having access to this series, comprising, in the words of Jenkins, "the finest collection of authoritative papers on fishery problems."

From the admirable work of Jenkins, cited below, much of our data concerning statistical publications in European countries has been obtained.

General treatises

Text in English. Goode, G. B. 1883.9; Hérubel, M. A. 1912.1; Russell, E. T. 1891.1; Willis-Bund, J. W. 1899.1; Wright, W. 1858.1; ★Wright, S. Add. **1908.1.**

See also "The Sea Fisheries," *by* ★J. T. Jenkins, London, 1920. 299 p. 57 pls.

Text in French. Baudrillart, — 1827.1; Bertrand, J. E. 1779.1; Broca, P. 1865.1; Delisle de Sales, — 1769.1; Dralet, — 1821.1; ★Duhamel du Monceau, H. **1769.1**, 1775.1, 1796.1; Hérubel, M. A. 1911.1; Karr, A. 1855.1–1860.1; ★La Blanchère, P. **1868.2**; ★Noël de la Morinière, S. 1815.1; Perreau, J. H. 1904.1; Roule, L. 1914.8; Wallon, E. 1868.1; Thomassy, M. J. Add. 1852.1.

Text in German. ★Borne, M., Benecke, B., & Dallmer, E. **1886.1**; Duhamel du Monceau, H. 1773.1; Lindeman, M. 1880.1; Meyer, J. 1881.1; Walter, E. 1903.1; Wirth, J. G. 1862.1; Anon. 633.

Text in Spanish. Valverde, — 1879.1.

Bibliographies: *A selected bibliography of marine bionomics and fishery investigations.* Allen, E. J. 1911.1. — *The literature of the ten principal food fishes of the North Sea.* Hoek, P. 1903.1. — *Bibliography of literature of sea and river fishing.* Manley, J. J. 1877.1–1883.1.

Historical matters

A popular history of fisheries from the earliest times. Adams, W. M. 1883.2. — *Origin of fishing.* Mortillet, L. 1867.1, 1890.1. — *Fisheries in 14th and 15th Centuries.* Segesser, A. P. 1852.1. — *The condition of the fisheries among the ancient Greeks and Romans.* Smidth, J. K. 1872.1, 1876.1. — *The royal fishery companies of the 17th Century.* Elder, J. R. Add. 1912.1. — *Das Fischereibuch Kaiser Maximilians I.* Hohenleiter, W., & Fritz, M. Add. 1901.1. — *Fisheries of Pomerania in 12th and 13th Centuries.* Sell, J. J. Add. 1797.1, 1831.1.

Instruction in fisheries

General: Practical uses of fisheries charts. Finn, W. 1871.1. — *Technical education in relation to fishermen's occupations.* Robertson, J. W. 1916.1. — *Need of a national institute (U. S.) for technical instruction.* Smith, H. M. 1914.2. — *Practical instruction in oceanography.* Thoulet, J. Add. 1911.1.

Instruction offered at the Fisheries Laboratory at Bergen, Norway. Dean, B. 1901.2. — *At Norrnäs, Sweden.* Lundberg, R. 1879.1. — *Die Fischerschule in Evois, Finland.* Schneider, G. 1904.5, 1907.7. — *Fischereischule des Bayerischen Landes Fischereivereins in Starnberg.* Hein, W. Add. 1910.1. *See also* Bull. U. S. Fish Comm., 1895, xv, p. 321. — *Deutsche See-Fischerei Verein.* Henking, H. Add. 1910.1.

Ecole professionnelle de pêche à Ostende (Belgium). For description and photographs by M. Pype, consult Mém. et C. R. Congr. Intern. de Pêche et de Pisciculture à St. Pétersbourg, 1902 (1903), pp. 212–213.

Lancashire Sea Fisheries Station at Piel, England. For syllabus used in classes for fishermen, see Johnstone, J. *in* Rept. Lancashire Sea-Fisheries Lab., 1903 (1904), no. 12, pp. 109–128.

Living conditions of fisherfolk

Economic conditions and means for their improvement. Various items. Adams, W. M. 1883.2; Bertram, J. G. 1883.2; Blanchard, C. E. 1869.3; Levi, L. 1883.1.

French sea-fishermen. Acloque, A. 1903.1. — *Fisherfolk of Kastrup, Denmark.* Feddersen, A. F. 1878.1. — *The fishermen of the United States. General review.* Goode, G. B., & Collins, J. W. 1887.3; Collins, J. W. Add. 1894.1. — *Netherlands fishermen.* Hoek, P. 1896.3, 1908.3, 1910.1. — *Credit institution for improvement of conditions among French fishermen.* Mallet, — 1866.2. — *Seagoing fishermen of Astrakhan.* Nikolskii, A. M. 1898.2. — *Swedish fishermen.* Nordström, L. 1907.1. — *Alliance of fishermen of Finkenwärder I., near Hamburg.* Voigt, F. 1878.2. — *Insurance among fisherfolk of the Great Belt, Denmark.* Winther, G. P. 1876.1. — *Italian fishermen in Algeria.* Palmisano, A. G. Add. 1904.1.

Science and Fisheries

Various articles on the relation of scientific investigation to commercial fisheries. Chudeau, R. 1900.1; Dröscher, W. 1902.1; Halbfass, W. 1902.1; Hoek, P.

1905.1,.2; Janson, O. 1914.1; Kammerer, P. 1910.2; Ryder, J. A. 1894.1; Schiemenz, P. 1901.1, 1902.3; Zacharias, E. O. 1904.2.

APPARATUS & APPLIANCES

For equipment, such as dynamite, hooks, lights, poisons, spears, etc., used by native races in fishing for their own consumption, *see under* Fishing Methods.

General treatises. Perrier, J. O. 1904.1; Wilcocks, J. C. 1868.1.

Miscellanea. Delidon, E. S. 1869.1; Holdsworth, E. W. 1883.1; Leonhardt, E. E. 1906.5; Perreau, J. H. 1904.1; Walsh, R. F. 1883.1; Heublein, C. J. Add. 1774.1,.2; Pontoppidan, E. Add. 1787.1; Wright, S. Add. 1908.1. — *Description of fish-measuring board.* Riddell, W. 1914.1. — *Fishery apparatus at Internat. Exposition at Bergen*, 1865. Soubeiran, J. L. 1866.2.

Fishing vessels: *Construction and equipment.* Baird, S. F. 1871.16; Nardo, G. D. 1870.1; Noël de la Morinière, S. 1806.1; Omond, J. 1883.1; Parona, C. 1899.1; Collins, J. W. Add. 1890.1.

Fish wells, live-boxes, etc., *for the transportation of fishes to market.* Berthelot, S. 1865.1,.3; Dempster, H. 1868.1; Hughes, S. E. 1884.1; Tytler, R. C. 1865.1. — *Pre-Linn. ref.* Steele, R. 1718.1.

Nets, seines, etc.: *Construction.* Morris, C. W. 1883.1; Schneider, G. 1909.5; Augur, C. H. Add. 1894.1. • *Various types of nets: Cruive (fish-trap) fisheries in Scotland.* Calderwood, W. L. 1899.1. — *Gill-nets.* Collins, J. W. 1880.1, 1885.3. — *Action of herring seine-net.* Fulton, T. W. 1900.2. — *Drag seine (chalut), in France.* Hennequin, A. 1867.1. — *Purse seine.* Hoek, P., & Bottemanne, C. 1888.1; Martin, S. J. 1883.1; Anon. 41. — *Fyke-nets.* Smith, H. M. 1894.4. — *Covered nets.* Todd, R. A. 1908.1. — *Pound nets.* True, F. W. 1887.2. — *Drag-nets.* Gilson, G. Add. 1911.1.

Trawls: *Use of beam trawl, etc.* Ansell, A. W. 1883.1; Dantziger, C. 1879.1; Collins, J. W. Add. 1889.1. — *Otter-trawl.* Kyle, H. M. 1900.3, 1905.1.

ASSOCIATIONS & SOCIETIES

For specific societies, *see under* the various countries, *below.*

Miscellaneous papers. Dimick, F. F. 1914.1; Espinas, A. V. 1879.1; Lindes, L. 1880.4; Olsen, O. T. 1908.1; Schneider, G. 1904.4; Surbeck, G. 1905.3.

COMMISSIONS OF FISHERIES

For the work of the fishery boards and commissions of the various countries, *see below under* Fisheries, arranged geographically.

International Commission for the Investigation of the Sea. (*Conseil Permanent International Pour l'Exploration de la Mer*). Subscribing governments are: Belgium, Denmark, Finland, Germany, Great Britain and Ireland, Netherlands, Norway, Russia, and Sweden. Central office in Copenhagen. Work has largely been confined to the North Sea.

The publications consist of "Rapports et Procès-Verbaux des Réunions," vol. I, 1903; "Bulletin trimestriel des résultats croisières périodiques," 1902; "Publications de circonstance," no. 1, 1903; *and* "Bulletin Statistique."

Scientific results of the commission. Garstang, W., 1905.2,.3,.6, 1906.1; Ekman, G., Pettersson, O., & Trybom, F. 1910.1; Heincke, F., & Henking, H. 1908.1; Helland-Hansen, B., & Nansen, F. 1909.2; Hjort, J. 1907.1–1910.2; Hjort, J. & Lea, E. 1911.1, 1912.1; ★Hjort, J. & Petersen, C. 1905.1; Hoek, P. P. 1903.2–1913.1; Hoek, & Kyle, H. M. 1905.1; ★Kyle, H. M. 1905.1–1908.1; Redeke, H. C. 1909.3; Anon. 142.

Early discussion concerning proposed plans of investigation. References under Allen, E. J. 1899.1. *See also* Ehrenbaum, E. 1902.1; McIntosh, W. C. 1903.3; Paton, D. N. 1902.2. *The reader should consult also the British* "Blue-books," *comprising an extensive literature relating to the International Investigations.*

CONGRESSES & ASSEMBLIES

Congresses of merely local importance will be found under the countries concerned. *See also* Expositions *below.*

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France: Cligny, A. 1912.11; Longuêty, L. 1860.1, 1868.1, 1878.1, 1879.1; Soubeiran, J. L. 1870.2; Garel, E. Add. 1911.1; Martel, E. Add. 1898.1.

Germany: Andrée, K. 1867.1; Apstein, C., & Hinklemann, A. 1898.1; Bock, F. S. 1769.1; Danziger, C. 1873.1, 1879.3; Freeden, — 1875.1; Groenewold, B. E. 1880.1; Hartemann, R. 1880.1; Henking, H. 1907.1; Herwig, — 1897.1; Kupffer, C. W. 1876.1; Lindeman, M. 1875.2; Münter, J. A. 1863.1; Rensen, P. 1872.1; Schleiden, M. J. 1866.1; Anon. 289, 438, 595; Friis, N. C. Add. 1777.1, 1778.1; Ljungman, A. W. Add. 1880.1; Möbius, K. Add. 1880.1.

Fisheries of Pomerania and Rügen in 12th and 13th Centuries. Sell, J. J. Add. 1797.1, 1831.1.

Iceland: Finn, W. 1880.1, 1882.1; Erichsen, J. Add. 1783.1; J. C. Add. 1885.1.

Netherlands: Danziger, C. 1879.3; Drossaart, P. K. 1868.1; Ehrenbaum, E. 1889.1; Gunn, W., & McLeod, M. G. 1889.1; Hoeven, J. 1852.1; Jonge, D., Kobel, H., & Salieth, M. 1792.1; Parser, M. 1868.1; Rietstap, G. H. 1864.1; Smith, H. M. 1904.10; Soubeiran, J. L. 1873.1; Winkler, T. C. 1852.1; Anon. 13; C., N. Add. 1905.1; Evers, F. S. Add. 1906.1; Freeden, W., Dantziger, C., & Rensen, P. Add. 1871.1.

Pre-Linn. *references.* Aitzema, L. 1669.1; Burrish, O. 1728.1; Laan, A. 1700.1; Meulen, S. 1700.1; Semeyns, M. 1639.1.

Norway: Andersen, O. 1868.2; Badeigts de Laborde, — 1815.1; Blanchard, C. E. 1882.1; Boeck, A. 1862.1–1875.1; Boeck, A., & Feddersen, J. 1876.1; Broch, H. 1907.1; Broch, O. J. 1882.1; Brunchorst, J. 1889.1; Buch, S. A. 1886.1; Dahl, K. 1909.4; Friis, N. C. 1770.1, Add. 1770.1,.2,.3,.4, 1771.2,.3; Heincke, F., & Henking, H. 1900.1; Laing, S. 1851.1; Maude, A. 1859.1; Milne-Edwards, A. 1878.1; Watt, W. 1883.2.

Sweden: *Chiefly Bohuslan fisheries.* Andersen, O. 1868.1,.2; Baird, S. F. 1878.4; Boeck, A. 1870.1, 1871.1, 1874.1; Ekström, C. U. 1844.1, 1850.3; Finn, W. 1878.2; Hollberg, L. 1819.1; Lindahl, J. 1879.1; ★Ljungman, A. V. 1874.1–1886.1, (*Periodicity*) 1879.2, 1882.1, 1885.2; Lönnberg, A. J. 1889.1; Malm, A. H. 1887.1, 1903.1; Malm, A. W. 1861.1, 1880.2; Tomfohrde, T. 1909.1; Watt, W. 1883.2; Widegren, H. 1870.3; Yhlen, G. 1875.1, 1879.2; Anon. 101, 691; Smitt, F. A. Add. 1895.1; Strandberg, O. Add. 1772.1,.2; Humble, N. Pre-Linn. 1745.1.

MACKEREL FISHERIES

American fisheries: Baird, S. F. 1877.8; Bean, T. H. 1887.3; Collins, J. W. 1881.2, 1884.5; Cremony, J. C. 1870.1; Gilpin, J. B. 1863.1, 1878.1; Goode, G. B. 1878.10, 1883.2; ★Goode & Collins, **1887.8**; ★Goode, Collins, Earll, & Clark, **1884.1**; Kendall, W. C. 1910.2; Martin, S. J. 1882.1,.12, 1883.2; Philips, B. 1883.1; Rich, S. 1879.1; Smiley, C. W. 1883.5; Wood, Wm. 1873.1. — *Southern spring fishery.* ★Smith, H. M. **1899.8**.

European fisheries: *Chiefly of northwestern Europe.* Brown, Richard. 1880.1; Cornish, T. 1876.1, 1880.2, 1881.2, 1883.2, 1891.1; Gauss-Garády, V. 1909.1; Lönnberg, A. J. 1911.4; Marion, A. F. 1894.6 (*Marseilles, France*); Pozniakov, A. 1908.1; Rietstap, G. H. 1870.1; Willumsen, P. J. 1882.1; Anon. 352; ★Ehrenbaum, E. Add. **1914.2**.

British Isles: *Chiefly England.* Allen, E. J. 1909.1; Bullen, G. E. 1908.1, 1913.1; Calderwood, W. L. 1891.1; Collins, J. W. 1885.1; Couch, J. 1844.2; Green, W. S. 1894.1 (*Ireland*); Ridge, R. J. 1889.1; Scott, A. 1914.1.

Spanish mackerel: *Origin and development of fisheries.* Earll, R. E. 1883.2, 1887.9.

MENHADEN FISHERIES

For the use of menhaden for fertilizer and oil, *see above under* Economic products.

American menhaden industry. De Blois, E. T. 1882.1; Friedländer, O. O. 1883.1, Add. 1883.1; ★Goode, G. B. **1879.7**, 1882.3; ★Goode & Atwater, **1880.1**; ★Goode & Clark, **1887.1**; Hathaway, W. E. 1908.1; Hawkins, J. W. 1882.1; Kendall, W. C. 1910.2; Mosher, G. 1882.1; Smith, H. M. 1896.1; Varigny, H. C. 1894.1; Maddocks, L. Add. 1878.1.

For many items entitled "Statement concerning the menhaden fishery," *and listed under individual authors, see* Rept. U. S. Fish. Comm. 1877 (1879), vol. V.

MULLET FISHERIES

Chiefly South Atlantic States of United States. Baird, S. F. 1877.9; Kishinouye, K. 1898.3 (*Japan*); Philips, B. 1884.2; Symons, J. 1874.1 (*Cornwall, Eng.*); Yarrow, H. C. 1874.1; ★Earll, R. E. Add. **1889.1**.

Botargo, salted mullet roe. Armand, B. 1897.1; Wallut, C. 1863.1.

PILCHARD, See SARDINE

RED SNAPPER FISHERIES

Chiefly of Gulf of Mexico, around Cuba and Florida. Collins, J. W. 1885.2, 1887.3, .4; Garcia Canizares, F. 1911.1; ★Stearns, S. **1887.3**; Warren, A. F. Add. 1898.1.

SALMON FISHERIES

For treatises on the salmon as a game fish, *see under* Angling. For life-histories, habits, etc., *see* Salmonidæ.

America

A most readable and comprehensive treatise is the "Pacific Salmon Fisheries" *by* ★J. N. Cobb, *published as* Append. I *to the* Rept. U. S. Comm. Fisheries, 1921 (Bur. Fish. Doc. No. 902), 268 p., 48 figs.

Alaska: ★Bean, T. H. 1890.26a, **1891.18**, 1894.1; Cobb, J. N. 1905.2, 1910.1; James, B. W. 1893.1; Jordan, D. S., & Evermann, B. W. 1904.3; Kutchin, H. M. 1899.1, 1907.1; McDonald, M. 1894.2; ★Moser, J. F. **1899.1, 1902.1**; Tingle, G. R. 1897.1; Zur Mühlen, M. 1911.1.

California: *Chiefly Sacramento River.* Baird, S. F. 1875.32,.33; Dall, W. H. 1883.1; Kirkpatrick, C. A. 1860.1; Redding, J. D. 1889.1; Serre, P. 1899.1; Stone, L. 1874.7; Jordan, D., & Gilbert, C. Add. 1887.1.

First salmon cannery established at Sacramento, Cal., in 1864 *by Wm. Hume, G. W. Hume, and A. S. Hapgood.* Adams, E. H. Add. 1885.1; Hume, R. D. Add. 1904.1.

Columbia River: *Oregon and Washington.* A. 1874.2; Baird, S. F. 1875.23; Barin, L. T. 1886.1; Carll, W. E. 1904.1; ★Cobb, J. N. 1911.1; Cox, R. 1831.1; Dawson, G. M. 1879.1; ★Evermann, B. W., & Meek, S. E. **1898.1**; Franchère, G. 1820.1, 1854.1; Gilbert, C. H. 1912.2; ★Gilbert, C. H., & Evermann, B. W. **1894.1**; Green, L. W. 1887.1,.2; Grover, G. 1874.1; McDonald, M. 1895.3,.4; Mather, F. 1878.5,.6; Nordhoff, C. 1874.1; Rockwell, C. 1875.1; Smith, C. J. 1880.2; Stone, L. 1878.4, 1889.1; Swan, J. G. 1857.1; Wilcox, W. A. 1898.2, 1902.1; Willey, D. A. 1905.1; Abernethy, A. S. Add. 1886.1; Buschman, C. H. Add. 1914.2; Herbert, M. J. Add. 1914.1; ★Jordan, D. S., & Gilbert, C. H. Add. **1887.1**.

Penobscot River: *Maine.* Atkins, C. G. 1868.1–1912.1; Evermann, B. W. 1905.9; Hamlin, A. C. 1874.1; Lincoln, T. 1874.1; Smith, H. M. 1898.5; Wood, Wm. 1873.1.

Asia

Siberia: *Amur River.* Zur Mühlen, M. 1911.12.

Europe

British Isles: *General and including England.* Ashworth, T. 1868.1; Cornish, J. 1824.1; Fryer, C. E. 1883.3; Home, D. M. 1884.1; Hutchinson, H. G. 1900.1; Jardine, W. 1862.1; Russel, A. 1864.2; Anon. 301, 637.

Ireland. Andrews, W. 1863.1, 1864.2, 1865.1; Blake, J. A. 1863.1; Holt, E. W. 1902.1, 1905.2,.3; Joynt, A. 1862.1; Reeves, R. W. 1866.1; Shiel, J. B. 1842.1; Anon. 483, 516, 527; Marin, G. Add. 1779.1.

Scotland. Buckland, F. T., & Young, A. 1871.1; Calderwood, W. L. 1900.1, 1904.6, 1912.1, 1913.1, Add. 1889.1, 1914.1; Home, D. M. 1882.1; Jopp, A. 1860.1; Mackenzie, M. 1860.1; Tosh, J. R. 1895.1; Walpole, S., & Young, A. 1881.1; Anon. 425, 431, 437, 484, 597, 710; Archer, W. E. Add. 1893.2.

Continental Europe: *Denmark.* Feddersen, A. F. 1870.1; Skrydstrup, V. 1875.1.

France. Bénardeau, F. 1905.1; Bureau, L. 1891.1; David, — 1896.1.

Germany. Häpke, L. 1876.1–1913.1; Hoek, P. 1910.2; Hoek, P., & Trybom, F. 1907.1; Seidlitz, G. 1877.2; Stemann, — 1894.1; Trybom, F. 1910.1; Gissler, N. Pre-Linn. 1751.1.

Netherlands. Hoek, P. 1894.4; Quakernaat van Spijk, A. 1870.1, 1871.1; Roché, G. 1895.1.

Norway. Berthoule, A., & Vaillant, L. 1889.1; Dahl, K. 1909.4; Hetting, M. G. 1866.3, 1868.2, 1869.1; Maude, A. 1859.1.

Russia: Finland, Lapland, etc. Nordqvist, O. F. 1894.7, 1898.6, 1899.10; Oehberg, A. 1897.1; Räihä, — 1893.1; Sandman, J. A. 1892.3–1900.1; Hallström, G. Add. 1911.1.

Spain. Nava y Caveda, H. 1878.1.

Sweden. Hetting, M. G. 1866.3; Trybom, F. 1887.2; Wollebaëk, A. 1904.1; Marin, G. Add. 1774.1, 1778.1.

Switzerland. Fankhauser, F. 1906.1; Matthey, L. 1880.2; Plattner, S. 1879.1.

SARDINE FISHERIES

Methods of preservation. Castillo, L. 1912.5; Müller, C. 1909.1; Pérard, J. Add. 1913.1.

Roe (*Rogue*), *used as bait; preparation and use in Sardine Fisheries.* Cépède, C. 1910.4; Landrieu, G. 1904.1; Smith, H. M. 1902.4.—*French imports in* 1881. Paulsen, P. G. 1884.1.

France: *Chiefly coast of Brittany.* Baudouin, M. 1888.1; Blavier, A. 1882.1; Caillo, — 1855.1; Delidon, E. S. 1866.1, 1869.1; Fabre-Domergue, P. 1897.1, 1913.1, Add. 1913.1; Gifford, G. 1883.1; Künstler, J. 1903.1; Launette, P. 1882.1, Add. 1887.1; Odin, A. 1896.1; Peyron, S. 1864.1; Pouchet, G. 1886.1–1891.3; ★Smith, H. M. **1902.4**, 1904.3, 1909.1; Vauvert, M. 1870.1; Anon. 700; Berthoule, A. Add. 1887.1; Bouvier-Lapierre, E. Add. 1887.1; Cligny, A. (*Bibliography*) Add. 1913.2, 1914.2; Rodel, A. Add. 1913.1; Deslandes, A. F. Pre-Linn. 1727.1.

Fisheries — *Cont'd.*

Other European countries: *Spain.* Albert I, H. C. 1887.2; Cornide, J. 1774.1; Smith, W. A. 1891.1. — *Norway.* Hjort, J. 1913.1. — *Portugal.* Nobre, A. 1895.2, .3. — *Finland.* Arvelin, J. E. Add. 1893.2

English pilchard fisheries: *Adult form of the sardine.* Bolitho, T. S. 1851.1, 1864.1; Chester, J. 1835.1; Cornish, T. 1883.2; Couch, J. 1835.1, 1840.1; Courtenay, J. S. 1840.1; Fox, Howard, 1885.1; Roberts, W. (*1816–1871*) 1871.1; Roach, W. 1889.1; ★Wilcocks, J. C. **1883.2;** Collins, W. Add. 1851.1; Swithinbank, H., & Bullen, G. E. Add. 1913.1, 1914.1.

American Industry: *Young herring canned as sardines.* Bensley, B. A. 1902.1; Brevoort, J. C. 1873.1; ★Earll, R. E. **1887.4;** Earll, R. E., & Smith, H. M. 1889.1.

SHAD FISHERIES

Chiefly of South Atlantic States of U. S.; Delaware, Potomac and Susquehanna Rivers. Atkins, C. G. 1887.2 (*Maine*); Blackford, E. G. 1879.2, 1884.1, 1887.1; Boyer, J. 1909.1; Chalker, R. B. (*Connecticut*) 1887.1,.2; 1889.1; Cobb, J. N. 1906.3; Ferguson, T. B. 1884.1; Goode, G. B. 1874.4; Hallock, C. 1895.1; Harris, G. 1884.1,.2, 1885.1, 1887.1; Howell, S. 1837.1; Huske, C. J. 1884.3; Lennurt, J. T. 1883.1; McDonald, M. 1884.5; Mather, F. 1885.4 (*Hudson R.*); Osborn, J. H. 1882.1, 1883.1; Smiley, C. W. 1883.12, 1884.10; Smith, H. M. 1906.1; Willis, H. 1882.1; Wood, W. M. 1884.1, .2; Wright, H. 1884.1, Add. 1882.1; Yarrow, H. C. 1874.1,.2,.5; Milner, J. W. Add. 1882.1; Stevenson, C. H. Add. 1899.2.

Shad fisheries of the Pacific coast. (The shad was introduced into the Sacramento River in 1871.) Smith, H. M. 1896.3; Wilcox, W. A. 1898.2, 1902.1, 1906.1.

SPRAT FISHERIES

Chiefly North Sea fisheries around Norway and Scotland. Ehrenbaum, E. 1910.4; Fletcher, J. 1905.1, 1906.1; Koefoed, E. 1909.1; Logan, G. 1863.1,.2; ★Lund, O. **1910.1;** Martin, W. 1862.1; Matthews, J. D. 1884.1; Redeke, H. C. 1900.3, 1910.1 (*Netherlands*); Sars, G. O. 1894.1 (*Norway*); Schneider, G. 1910.2; Anon. 595. — *Finland.* Arvelin, J. E. Add. 1893.1–1894.1. — *Spain.* Fernandez, C. Add. 1850.1.

STURGEON FISHERIES

France. Roule, L.1905.3.

Germany. Boettger, O. 1871.1; Noll, F. C. 1871.1; Quamtz, H. 1903.1; Schneider, O. 1879.1; Stemann, — 1894.1; W. 1896.1.

Russia. Baženov, A. 1906.1; Borodin, N. A. 1897.1, 1901.2; Kavraiskii, T. T. 1907.1; Nordqvist, O. F. 1896.7; Saurén, H. 1895.1; Savostickij, N. G. 1901.1; Tichij, M. 1912.2; Wetterich, A. 1880.1 (*Siberia*); Wight, J. 1901.1.

United States. Cobb, J. N. 1900.2; Hovey, H. C. 1884.1; Kalm, P. 1761.1; ★Ryder, J. A. 1890.4; Stockwell, G. A. 1875.1, 1883.1; Tower, W. S. 1908.1; Meehan, W. E. Add. 1899.1; Smith, H. M. Add. 1913.3.

" Spoonbill sturgeon " (*Polyodon*), *caviar industry of lower Mississippi.* Hussakof, L. 1910.5, 1911.3.

Caviar industry of Canada. Prince, E. Add. 1905.1.

TUNNY FISHERIES

Mediterranean fisheries, chiefly about coasts of Italy and Sicily. Hintze, A. 1884.2; Muth, J. P. 1869.1; ★Pavesi, P. **1889.1;** Raggi, G. A. 1894.1; Russo, A. 1913.1; Turrel, L. 1872.2, 1875.1, 1877.1; Anon. 528; Amico, F. C. Add. 1816.1; Bounhiol, J. P. Add. 1911.1; Brydone, P. Add. 1806.1; Galliani, A. Add. 1903.1.

WHITEBAIT

Considered young of Allis shad. Donovan, E. 1802.1.

Considered a separate species, Clupea alba *Yarrell.* Cuvier, G., & Valenciennes, A. 1848.1; Lawson, H. 1865.1; Lord, J. K. 1870.1; Parnell, R. 1832.4, 1837.2, 1839.4; Yarrell, W. 1829.1.

First demonstration by Günther of identity with young herring (C. harengus). Günther, A. 1868.5; Tegetmeier, W. B. 1868.1; Anon. 629.

American and English Whitebait, i. e. *young herring.* Blackford, E. G. 1878.1, 1879.4,.5, 1880.2; Brevoort, J. C. 1873.5; Day, F. 1879.5; Ewart, J. C. 1888.6; Scott, A. 1915.2; Sim, G. 1883.2; Ewart, J. C., & Matthews, J. D. Add. 1886.1.

Composition of Whitebait at Nice, France; young of Alosa, Aphya, Mugil, Smaris, Gobius, etc. Pellegrin, J. 1904.11.

New Zealand Whitebait, composed of young Galaxias. Gibson, E. 1903.1; MacKenzie, A. J. 1903.1; Powell, L. 1870.1.

WHITEFISH FISHERIES

Great Lakes Whitefish industry of America. Barnston, G. 1874.1; Gauthier, C. W. 1911.1; ★Geare, R. I. **1884.1;** Kerr, J. W. 1874.1; Kiel, P. 1874.1; Stockwell, G. A. 1875.3; Wilson, C. H. 1913.1; Anon. 148, 630. Patton, M. F. Add. 1912.1; Smith, R. Add. 1908.1.

European Whitefishes; (Maraene, Felchen, Renke, etc.). Austria. Clodi, E. 1911.1. — *Scotland.* Cowe, R. 1834.1. — *Germany.* Borne, M. 1880.3; Dallmer, E. 1878.3; Eisfeld, H. 1880.1; Halbfass, W. 1901.1; Leonhardt, E. E. 1903.9; Max, C. 1911.1; Seidlitz, G. 1879.1; Skowronnek, F. 1912.1; Wengen, — 1878.2. — *Switzerland.* Lankester, E. R. 1912.1; Surbeck, G. 1914.1, 1915.1. — *Finland.* Nordqvist, O. F. 1897.6, 1898.3, 1900.13. — *Norway.* Friis, N. C. Add. 1771.2,.3, 1778.1.

Fisheries Arranged Geographically

AFRICA

General: Adam, V. 1839.1; Puenta y Olca, P. 1885.1.

East Coast; Indian O. and Red Sea. Alluaud, C. 1904.1; Endicott, C. 1887.1; Klunzinger, C. B. 1871.3; Merle, A. 1879.1; Anon. 684.

West coast or Atlantic fisheries. Aube, F. 1872.1; Band, H. 1879.1; Berthelot, S. 1840.1; Gruvel, A., & Bouyat, A. 1906.1; Robertson, G. A. 1819.1; Schultze, L. S. 1907.1; Stassano, E. 1890.1; Berthoule, A. Add. 1888.1; D., G. Add. 1905.1.

French Colonies, fisheries. Darboux, G., Stephan, P., Cotte, J., & Gaver, F. Add. 1907.1; Pellegrin, J. 1906.6, 1909.11; Regelsperger, G. 1905.1.

Algeria: Bonnard, A. 1902.1; Bounhiol, J. P. 1907.1, 1908.1; ★Bourjot, A. **1869.1**; ★Bouchon-Brandely, G. J., & Berthoule, A. **1891.1**; Cacheux, E. 1903.1; Cépède, C. 1907.5; Chudeau, R. 1905.1; Layre, — 1899.1; Peixotto, B. F. 1884.1; Perissat, G. 1889.1.

Canary Is.: Puenta y Olca, P. 1885.1; Taquin, A. 1902.1.

Cape Colony: Gilchrist, J. D. Add. 1914.3; Jardine, A. J. 1830.1; Siler, J. W. 1885.1. — *Cape of Good Hope.* Schultze, L. S. 1907.1; Kolbe, P. Pre-Linn. 1731.1.

Cape Verde Is.: Cardoso, J. 1895.1.

Egypt: ★Mitchell, J. C. **1895.1**–1898.1. — *Nile R.* Werner, Franz, 1906.2.

Guinea: *Gold Coast.* Moloney, C. A. 1883.1; Müller, W. J. Pre-Linn. 1675.1.

Kamerun: Ehrenbaum, E. Add. 1914.7; Anon. 669, 707.

Kongo, Belgian: Goffin, A. 1909.1; Wilverth, E. 1897.1, 1911.1.

Madeira Is.: Syle, L. D. 1885.1.

Senegal: Gruvel, A. 1905.1, 1908.1, 1911.1, Add. 1913.1; Hautreux, J. A. Add. 1888.1.

Tunis. ★Bouchon-Brandely, G. J. B. & Berthoule, A. **1891.1**; Espitallier, G. Add. 1901.1; Fages, E., & Ponzevra, C. Add. 1908.1.

AMERICA

NORTH AMERICA

ALASKA

General: ★Bean, T. H. **1887.8**, 1889.5; ★Cobb, J. N. 1905.2, **1906.1**, **1907.2**, 1911.1, Add. 1914.2; ★Dall, W. H. **1870.1**, 1871.1; ★Evermann, B. W. 1911.1–1913.1, **1914.1**, Add. 1911.1; Goode, G. B. 1881.8; James, B. W. 1895.1; H., A. R. 1879.1; Marsh, M. C., & Cobb, J. N. 1908.1; Murdoch, J. 1885.1 (*Point Barrow*); R., H. A. 1879.1; Tanner, Z. L. 1890.1, 1891.1; Bower, W. T. Add. 1914.1; Bower & Fassett, H. C. Add. 1914.1; Chamberlain, F. M., & Bower, W. T. Add. 1913.1.

Cod fisheries. Baird, S. F. 1871.9, 1874.1; Bean, T. H. 1887.2; Krause, — 1882.1; Lockington, W. N. 1879.5.

For salmon fisheries of Alaska, see under Fisheries, Salmon.

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Miscellaneous papers

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British Columbia: Gilbert, C. H. 1912.2 (*Fraser R., salmon*); Gosnell, R. E. 1897.1; Green, A. 1891.1; Macfie, M. 1865.1; McMurrich, J. P. 1913.3; Mooney, G. S. 1861.1,.2; Rattray, A. 1862.1; Tissandier, A. 1895.1; Babcock, J. P. Add. 1903.1, 1904.1; Bowser, W. J. Add. 1914.1; Rathbun, R. Add. 1900.1. — *Vancouver I.* Bogge, E. B. 1870.1; Macfie, M. 1865.1; Rattray, A. 1862.1; Edge-Partington, J. Add. 1900.1.

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FOOD AND FEEDING HABITS (*OF FISHES*)

In the sense of natural sustenance, as shown by their stomach contents and including habits of feeding.

For the proper food for fishes in cultivation, *see* Food and feeding-methods *under* Pisciculture.

For the stones often found in stomachs of fishes, *see* Gastroliths.

For related topics, *see* Assimilation *under* Physiology, *and also* Digestion.

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FOOD OF VARIOUS FISHES

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FORM OF FISHES

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GASTROLITHS (*STOMACH STONES*)

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For a list of catalogues of works on natural history, *see* Part IV of this work on "General Bibliographies."

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Text in Dutch. Burgersdijk, L. A. 1862.1; Houttuyn, M. 1761.1; Vrolik, W. 1854.1.

Text in English. Brookes, R. 1763.1, 1773.1, 1790.1; Buffon, G. L. 1831.1, 1860.1; Cuvier, G. L. 1834.1,.2, 1840.1; Goode, G. B. & others 1887.1; ★Harmer, S. F. **1904.1**; Hill, J. 1771.1; Kingsley, J. S. 1885.1; Lamarck, J. B. 1914.1; ★Lankester, E. R. **1900.1**; Lydekker, R. 1894.1, 1903.1; Lydekker, R., Johnston, H. & others 1910.1; Pycraft, W. 1910.1; Shaw, G. 1800.1; Shaw, G. & Nodder, F. P. 1790.1; Swainson, W. 1820.1, 1838.1; Turton, W. 1802.1; Fleming, J. Add. 1822.1.

Text in French. Beaurieu, G. G. 1770.1; Beudant, F. S., Edwards, H. M. & Jussieu, A. L. 1867.1; Bomare, J. C. 1764.1; Bory de Saint-Vincent, J. B. 1822.1; Buc'Hoz, P. J. 1771.2; Buffon, G. L. 1798.1–1834.1; Chenu, J. C. 1874.1; Chevrolat, L. A. 1839.1; Cuvier, G. F. 1804.1; Cuvier, G. L. 1817.1, 1829.1, 1836.1, 1844.1; Knorr, G. W. 1766.1; Lacépède, B. G. 1844.1; La Chenaye-Desbois, F. A. 1759.1; Lamarck, J. B. 1809.1; Orbigny, A. C. 1839.1; ★Perrier, J. O. E. **1903.1**; Sonnini de Manoncourt, C. N. 1799.1; Valmont de Bomare, J. C. 1765.1; Virey, J. J. 1835.1; Anon. 662.

Text in German. Borowski, G. H. 1784.1; Brehm, A. E. 1863.1, 1876.1, 1892.1, 1914.1; Bronn, H. G. 1859.1, 1874.1; Cuvier, G. L. 1831.1, 1846.1; Kaup, J. J. 1835.1; Lenz, H. O. 1838.1–1878.1; Leunis, J. 1844.1–1883.1; Martin, P. L. 1876.1; Martini, F. H. 1774.1; Oken, L. 1816.1, 1833.1; Suckow, G. A. 1797.1; Voigt, F. S. Add. 1831.1.

Text in Spanish. Brehm, A. E. 1882.1; Chao, E. 1852.1.

Lesser Works on Natural History

Text in English. Baird, S. F. 1852.1; Brown, T. 1832.1; Cuvier, G. F. 1840.1; Donovan, E. 1823.1; Duncan, F. M. 1913.1; Edwards, G. 1758.1; Goldsmith, O. 1774.1–1858.1; Holloway, W. & Branch, J. 1804.1; Jenyns, L. 1846.1; Jordan, D. S. 1876.2–1899.2; Jordan, D. S. & Van Vleck, B. H. 1874.1; ★Lydekker, R. **1912.1**; Lydekker, R. & others 1897.1; Mayo, B. 1818.1; Pluche, N. A. 1785.1; Shufeldt, R. W. 1897.3; Smith, T. 1806.1; Stark, John 1828.1; Wood, J. G. 1861.1; Wood, William 1807.1; Anon. 187, 345, 374; Forbes, E. Add. 1859.1; Ruschenberger, W. S. Add. 1856.1; Strong, A. B. Add. 1851.1.

Text in French. Alléon, D. 1765.1; Bertrand, J. E. 1779.1; Boitard, M. P. 1827.1; Cuvier, G. L. 1798.1; Pluche, N. A. 1763.1; Rafinesque-Schmaltz, C. 1815.1; Raymond, G. M. 1828.1; Virey, J. J. 1822.1.

Text in German. Bertuch, F. J. 1806.1; Hesse, R. & Doflein, F. 1910.1; Müller, J. T. 1780.1; Ramisch, F. H. 1835.1; Strack, –. 1819.1; Vogt, C. C. 1851.1; Wiedemann, C. R. 1800.1; Wilhelm, G. T. 1817.1; Wilmsem, F. P. 1831.1; Anon. 390.

Pre-Linnæan Works

Including natural histories, encyclopædias and early general works containing references to fishes.

Most of these works appeared in several editions and in various languages. Ad-Damĭrĭ, I. K. 1372.1; Andrew, L. 1510.1;

★Aristotle, 1476.1; Bartholomæus Anglicus. 1470.1; Birckerodius, T. B. 1694.1; Brisson, M. J. 1754.1; Burton, R. 1678.1; Candidus, D. P. 1460.1; Cerutus, B. 1622.1; Coetlegon, D. 1745.1, 1746.1; Cube, J. 1485.1; Cupani, F. 1713.1; Edwards, G. 1743.1; Franciscus, E. 1668.1; ★Gesner, C. **1558.1**, 1575.1, 1619.1; Gilles, P. 1535.1; Hill, J. 1748.1; Hildegarde de Pinguia 1533.1; Hövel, H. 1601.1; Johnson, T. 1595.1; ★Jonston, J. **1632.1**; Konrad of Megenburg, 1475.1; Knorr, G. W. 1754.1; Kräutermann, V. 1730.1; Lonicer, A. 1551.1; Marsigli, L. F. 1725.1; Martyn, B. 1735.1; Münster, S. 1543.1; Muralt, J. 1709.1,.2; Neckham, A. 1180.1; Nieremberg, J. E. 1635.1; Nylant, P. & Hextor, J. 1678.1; Petiver, J. 1702.1; ★Pliny, C. **1469.1**; Pluche, N. 1732.1; Raimondi, E. 1610.1; Reisch, G. 1496.1; Schnurr, B. 1654.1; Szent-Iványi, M. 1689.1; Vincent, L. 1715.1; Vincentius Bellovacensis 1473.1; Watson, F. 1754.1; ★Worm, O. **1655.1**; Zanardus, M. 1619.1; Anon. 731, 732, 733, 754, 755, 774.

POPULAR WORKS

Including anecdotes, marvels of fish life, narratives, tales of the sea, etc.

For legends and fables of fish life, *see* Mythology and symbolism.

Text in Dutch. Brussel, T. 1798.1; Hauwaert, P. 1901.1, 1901.2; Redeke, H. C. 1911.2; Richter, J. G. 1768.1, 1780.1; Anon. 319.

Text in English. Abbott, C. C. 1888.1; Adams, A., Baikie, W. B. & Barron, C. 1854.1; Adams, W. H. 1870.1; Agassiz, J. L. 1847.1; Arnold, A. & Samuel, E. A. 1868.1; Beavan, A. H. 1905.1, 1908.1; Bigland, J. 1828.1–1865.1; Boyd, J. P. 1888.1; Brown, T. 1835.1; Buckland, F. T. 1857.1, 1875.1, 1876.1, 1882.1; Bullen, F. T. 1899.1-1904.2; Bushnan, J. S. 1840.1; Clarke, S. C. 1892.1; Damon, W. E. 1877.1, 1888.1; Duncan, F. M. 1913.2,.3; Duncan, F. M. & Duncan, L. T. 1913.1; Elmhirst, R. 1913.2; Emerton, J. H. 1880.1; Esdaile, D. 1865.1; Furneaux, W. 1896.1; Gosse, P. H. 1849.1–1854.1; Hamilton, E. 1890.1; Harper, J. 1858.1; ★Holder, C. F. 1903.1, 1906.1, 1908.1, 1910.1,.3, 1913.1, Add. 1885.1–1912.1; ★Holder, C. F. & Jordan, D. S. **1909.1**; Jesse, E. 1832.1; McCarthy, E. 1900.1; Morris, F. O. 1860.1; Northrop, H. D. 1901.1; Ogilvie, G. 1858.1; Petersen, C. G. 1900.1; Prouty, L. 1883.1; ★Pycraft, W. **1901.1**; Reynolds, S. 1911.1; Simeon, C. 1860.1, 1863.1; Thompson, J. A. 1914.1; Trimmer, M. 1830.1; Walcott, J. 1788.1; Walcott, S. 1795.1; Wood, J. G. 1857.1; Wraxall, F. C. 1860.1; Baskett, J. N. Add. 1899.1; Boulenger, G. A. & Boulenger, C. L. Add. 1914.1; Cowan, F. Add. 1894.1; Davies, E. W. Add. 1887.1; Figuier, L. Add. 1869.1; Giberne, A. Add. 1902.1; Perry, W. A., Mosher, A. A. & others. Add. 1892.1.

Text in French. Blocquel, S. 1826.1; Buc'Hoz, P. J. 1769.1; Chailland, –. 1769.1; Dralet, –. 1821.1; Figuier, G. L. 1868.1, 1876.1; Haüy, R. J. 1787.1; Jannettaz, P. M. 1869.1; Moquin-Tandon, C. H. 1865.1, 1866.1; Oudart, P. L. 1825.1; Pérez, C. C. 1901.1; Ray, P. A. 1788.1, 1804.1.

Text in German. Buhle, C. A. 1812.1; Hartwig, G. L. 1857.1; ★Hentschel, E. **1909.1**; Krüger, J. G. 1759.1; Leonhardt, E. E. 1913.1; Leuckart, F. S. 1832.1; Marshall, W. A. 1898.1; ★Plehn, M. **1906.2**; Rauther, M. 1907.2,.3; Schreiber, – 1913.1; Anon. 633; Giebel, C. G. Add. 1860.1.

Text in Italian. Bianconi, C. G. 1848.1; Giglioli, E. H. & Issel, R. 1884.1; Doni di Nettuno. ★Cavanno, G. Add. **1914.1**.

Text in various languages. — *Swedish.* Aulin, H. 1760.1. — *Danish.* Fleischer, E. 1795.1. — *Russian.* Nikolskiĭ, A. M. 1902.1. — *Spanish.* Philippi, R. A. 1864.1. — *Latin.* Scopoli, G. A. 1787.1. — *Japanese.* Anon. 529.

ZOÖLOGIES

Comprising Handbooks, Manuals, Textbooks, etc.

Text in Danish. Boas, J. E. 1888.1.

Text in Dutch. Harting, P. 1862.3; Hoeven, J. 1849.1.

Text in English. Baird, S. F. 1851.1; Boas, J. E. 1896.1; Hertwig, C. W. 1913.1; Hoeven, J. 1856.1; ★Kingsley, J. S. **1900.1**; Lankester, E. R. 1889.2,.3, 1911.2; Marshall, A. M. & Hurst, C. H. 1887.1; Morgan, C. L. 1887.1; Nicholson, H. A. 1870.1, 1871.1; Packard, A. S. Jr. 1880.1; ★Parker, T. J. & Haswell, W. A. 1897.1; ★Sedgwick, A. 1885.1, **1898.1**; Shipley, A. E. & Macbride, E. W. 1901.1; Thomson, J. A. 1892.1, 1910.1; Wells, H. 1894.1; Wells, H. G. & Davies, A. M. 1913.1; Weyser, A. W. 1904.1; Parker, T. J. & Parker, W. N. Add. 1900.1.

Text in French. ★Delage, M. Y. & Hérouard, E. **1898.1**; Edwards, H. M. 1835.1; Pouchet, F. A. 1832.1, 1841.1.

Text in German. Boas, J. E. 1894.1; Brandt, A. T. 1911.1; Brühl, C. B. 1877.1; Carus, J. V. & Gerstaecker, C. E. 1863.1; Goette, A. 1902.1; Goldfuss, G. A. 1820.1; ★Hertwig, C. W. 1891.1, **1910.1**; Hertwig, W. A. 1906.1; Hilzheimer, M. & Haempel, O. 1913.1; Hufeland, –. 1798.1; Kner, R. 1849.1; Kuhl, H. 1820.1; Nusbaum, J., Karsten, G. & Weber, M. 1911.1; Pagenstecher, H. A. 1875.1; Thienemann, F. A. 1828.1; Treviranus, G. R. 1802.1; Voigt, F. S. 1835.1.

Text in Italian. Bassani, F. 1885.1; Doria, G., Ferrari, S. M. & Lessona, M. 1861.1–1869.1; Ranzani, C. 1819.1.

Medical Zoölogies. Brandt, J. F. & Ratzeburg, J. T. 1829.1; Czenpinski, P. 1778.1; Szirmay, A. I. Add. 1840.1.

GROWTH, AGE, AND SIZE

References to the development and growth of individual forms will be found under the various families and genera, under the heading Natural History.

Papers relating to metamorphosis and growth will be found under such families as Anguillidæ, Pleuronectidæ, and Salmonidæ.

For related subjects, *see* under such topics *as* Embryology, Form, etc.

For the relations between age and reproduction, *see* Sexual maturity *under* Reproduction.

Mode of growth. Henneguy, L. F. 1887.1; Packard, A. S. Jr., 1875.1. —*Distribution of form-building capacities in animal bodies.* Przibram, H. 1910.1. —*Lengthening process.* His, W. Add. 1891.1.

Relation of weight to length in Mustelus. Hecht, S. 1913.1.

Relative growth of organs and parts, Mustelus. Kearney, H. L. Add. 1914.1.

Relative dimensions of adults and young of Alopias vulpes. Vaillant, L. L. 1886.2.

Correlations of weight and length in the weakfish, Cynoscion regalis. Crozier, W. J. & Hecht, S. Add. 1914.1.

Miscellaneous and unimportant papers, notices, popular accounts, etc., on age and growth in fishes, age-determination from the point of view of the fish-culturist, etc.

Text in — English. Aflalo, F. G. 1902.4; Baird, S. F. 1876.21; Meek, S. E. 1900.3. — *Norwegian.* Dahl, K. 1911.2, 1912.1; Dahl, K., Damas, D. & Sund, O. 1909.1; Grieg, J. A. 1908.1; Nordgaard, O. 1901.1. — *Russian.* Emeljanenko, P. E. 1909.1; Grimm, O. 1901.2,.3, 1904.2; Heide, E. J. 1912.1; Ostroumov, A. A. 1910.1–1913.1. —*Finnish.* Ericcson, B. 1905.1. —*Swedish.* Hederström, H. 1759.1; Mäklin, F. W. 1864.1, 1865.1; Nordqvist, O. F.1907.2, 1909.2; Petersen, C. G. 1892.1. —*Dutch.* Hoek, P. P. 1912.3; Tesch, J. J. 1910.1, 1913.1. — *Italian.* Mazzarelli, G. F. 1904.1; Supino, F. 1910.1. —*Danish.* Otterstrøm, A. N. 1906.1. —*Japanese.* Watanabe, M. 1913.1.

Text in German. Apstein, C. 1900.1, 1909.1; Bartels, F. 1910.2; Braun, M. G. 1893.1; Cronheim, W. 1908.1; Lücke, Fr. 1911.1; Milewski, A. 1912.4; Popta, C. M. 1907.2; Reeker, H. 1909.1; Reuss, H. 1908.1,.2; Stieda, L. 1871.2.

METHODS IN DETERMINATION of age and growth

For a short historical résumé in English of the development in Europe of all the methods in the determination of growth and age, with the chief literature, see ★Dahl, K. 1909.1.

Older methods

Professor Sars attempted to begin with the newly hatched fry of the cod, measuring their growth and observing it year after year. Sars, G. O. 1865.1 *et seq.*

Similar observations on herring were made by Meyer, H. A. 1878.1,.2.

RATE OF GROWTH

A great stimulus to studies on age and growth was given by the work of Petersen. His method consisted chiefly in the mensuration of large numbers of immature fishes of all sizes to determine the limits of the various series or generations — the median point (or average) between the extreme limits of the series being taken as the mean of a "group-series" or annual "size-unit" or "year-class." By a study of these group-series, it was expected to determine the full growth-rate of a given species. Experience, however, has shown that, as a rule, only the first 2-3 year classes are recognizable.

Original statement of this method. Petersen, C. G. 1891.2, 1895.2.

Following this method, with slight modifications, observations chiefly on the rate of growth have been made as follows. — Flounder, plaice, dab, sole, turbot, whiting, poor cod, and pilchard. Cunningham, J. T. 1891.9,.11, 1892.2,.3. — *Plaice.* Dannevig H. C. 1899.1; Johnstone, J. 1908.2, 1910.4, 1912.4, Add. 1912.1, 1914.2; Kyle, H. M. 1905.2, 1907.1. —*Gurnard.* Fulton T. W. 1899.1. —*Cod, haddock, whiting and Norway pout.* Fulton, T. W. 1901.3. — *Plaice, dab, whiting and haddock.* ★Fulton, T. W. 1902.3, 1904.5. —*Herring.* Masterman, A. T. 1895.3. —*Cyclopterus, Cottus, Agonus and Liparis.* Tosh, J. R. 1894.1.

Unclassified. Fulton, T. W. 1893.2; Williamson, H. C. 1893.1. —*Description of a fish-measuring board.* Riddell, W. 1914.1, 1915.1.

Recent methods in age determination

In 1899 Reibisch showed that the otoliths of plaice exhibit a periodic growth corresponding to summer and winter and are thus available for age determination. Reibisch, J. 1899.1.

About the same time, Hoffbauer demonstrated that the annual rings in the scales of the carp provided an indication of the age. Hoffbauer, C. 1898.1 *et seq.*

Since then numerous parts have proven available. "The choice of the organ for age determination may now be considered as being a question of an entirely practical kind, a question to be answered for each species. We employ the organ which most easily and cheaply can be procured. Some investigators have used the otoliths. Others have employed certain bones, as gill-covers, scapulæ, vertebræ, or neural processes. Others again have preferred to use the scales." Dahl.

A comprehensive dissertation in German on otolith structure with regard to age determination is ★Fryd, C. 1901.1.

For a comprehensive treatise in English on age determination as based on scale studies, see ★Taylor, H. F. **1916.1**.

For an excellent popular paper on the relation of scale structure to growth in the Atlantic salmon, the meaning of the "spawning mark" on the scales, etc., see ★Hutton, J. A. Add. 1909.1.

ANGUILLA (Common eel)

As early as 1873, Baudelot suggested that the concentric zones in the scales of the common eel corresponded to periods of growth. Baudelot, E. 1873.4.

Other papers relating to the structure of the scales in regard to the determination of age in the eel. Ehrenbaum, E. & Marukawa, H. 1913.1; Gemzöe, K. J. 1907.1; Schneider, G. 1909.8; Haempel, O. Add. 1914.2.

CLUPEIDÆ

"Vertebræ as well as otoliths, also opercula and other flat bones are good, but none of these give so sure results as the scales." Dahl.

Otoliths used in analysis of age of herring. ★Jenkins, J. T. 1902.1. —*Both scales and otoliths used comparatively.* Broch, H. 1907.1–1908.2.

Various papers on the determination of age and growth, chiefly by the study of the scales, in the herring (Clupea harengus) with a few on the sprat (C. sprattus). Bounhiol, J. P. 1912.1; ★Dahl, K. 1907.2, **1909.3**; Fulton, T. W. 1906.1; Schneider, G. 1908.2, 1909.9; Storrow, B. 1914.1, 1915.1; Sund, O. 1909.1; Thompson, D. W. 1911.2, 1914.3; Delsman, H. C. Add. 1914.1,.2; Hensen, V. Add. 1914.1. —*Caspian herring (Clupeonella).* Nedozhivin, A. & Tichij, M. 1913.1.

The Norwegian investigators have greatly developed the application of "scale readings" based chiefly on the herring. They believe the scale studies indicate not only the age but the size at different years and the conditions of existence during those years. For the methods employed, see Lea, E. 1911.1, 1913.1. *For a discussion of these methods, noting "the phenomenon of apparent change in growth rate," see* Lee, R. M. 1912.2, Add. 1913.1.

For an elaborate monograph summarizing all the data on scale reading in the herring, see Molander, –. *in* Ur. Svenska Hydrographisk-Biologiska Kommissions Skrifter *for* 1917.

GADIDÆ

"The scales as a rule are far superior to any other organ taken from the osseous system."

The following papers on growth and age determination relate chiefly to the cod (Gadus morrhua) and the pollack (G. pollachius). Carr, A. M. 1909.1; Cunningham, J. T. 1905.1; Dahl, K. 1906.4; ★Damas, D. 1909.1; Hjort, J. 1908.2; Lee, R. M. (*Haddock*) 1912.2; Maier, H. N. 1906.1; Redeke, H. C. 1909.1; ★Thomson, J. S. 1902.1, **1904.1**, 1904.2; Winge, O. 1915.1.

Contrary to the almost universal opinion that the scales of fishes increase in size by annual growth rings, Brown (Alfred W. 1903.1) believes that in the cod, haddock, and whiting, the scales are annually shed after spawning until the age-limit of spawning is reached when no further shedding takes place.

PLEURONECTIDÆ

Among flatfishes, the plaice (*Pleuronectes platessa*) has been the chief subject of study. The structure of the otoliths, at least in younger fishes, provides a reliable index of age.

"As regards older fish the otoliths become too little transparent and the annual rings too close for an absolutely safe reading. In these cases the broad flat bones of the head and shoulder girdle are good subjects and give safer results." Dahl.

Otoliths first studied as indicators of age and growth. Reibisch, J. 1899.1.

Other papers on age and growth in plaice based on study of otoliths, bones, etc. Atkinson, G. T. 1908.1; Carr, A. M. (*Dab*) 1909.1; Cunningham, J. T. 1905.1; ★Heincke, F. 1906.1; Heincke, F. & Henking, H. 1908.1; ★Immermann, F. **1908.1**; Johansen, A. C. 1905.1 (i), 1909.1, 1910.1, 1912.1; McMurrich, J. P. 1914.1; Maier, H. N. 1906.1; Meek, A. 1903.1, 1905.1; Petersen, C. G. 1903.1; ★Wallace, W. 1905.1–1911.1.

VARIOUS FISHES

Papers on the determination of age and growth by recent methods have appeared as follows. —*Salmo hucho.* Haempel, O. 1910.1; Salomon, K. 1908.1. —*Smelt (Osmerus).* Masterman, A. T. 1913.2. —*Mackerel (Scomber).* Nilsson, D. 1914.1. —*Anchovy (Engraulis).* Redeke, H. C. 1914.1. —*Coregonus albula.* Seligo, A. 1908.2. —*Cynoscion regalis and Orthopristis chrysopterus.* ★Taylor, H. F. 1916.1. *Carp.* Walter, E. 1901.1.

For additional references to scale studies on salmon, see below "Growth" under both Atlantic and Pacific salmons under Salmonidæ.

LONGEVITY

Age attained by fishes

Records of ages attained by fishes. In some cases, the records are of fishes kept in aquaria; in others known individuals have been under observation in the ponds of European monasteries or marked specimens are alleged to have been taken from the moats of feudal castles.

Such records are as follows. —*Carp (375 yrs.).* Baird, S. F. 1872.9; Mehwald, – 1873.1. —*Carp (38 yrs.).* Noll, F. C. 1879.2, 1882.1. —*Carp (300 yrs.).* Suffield, R. R. 1874.1.

Pike (267 yrs.). Baldinger, E. G. 1802.1. —*Loach (260 yrs.).* Bötticher, W. 1902.1. —*Goldfish (30 yrs.).* Essing, L. 1898.1. —*Trout (19 yrs.).* Harvie-Brown, J. 1898.1. —*Sea bass (21 yrs.).* Townsend, C. H. Add. 1913.5.

Miscellaneous items on longevity in —Carp. Falke, W. 1874.1. —*Pop. art. in French.* Oustalet, E. 1900.1. —*Trout.* Stone, L. 1872.5. —*Goldfish.* Riepe, E. Add. 1906.1.

SIZE ATTAINED

Popular article, "Some giant fishes of the sea." Smith, H. M. 1909.4.

Growth — *Cont'd.*

Largest and smallest of known fishes. Lönnberg, A. J. 1902.10; Henn, A. W. Add. 1912.1.

A minute goby (Mistichthys luzonensis) from the Philippines, of which egg-bearing, mature females only twelve mm. long have been taken, is the smallest known vertebrate. Smith, H. M. 1902.5,.8,.11,.13, 1903.3. *Figured in* 1902.8.

The whale shark (Rhineodon typus), of which specimens forty-five feet in length have been captured, is the largest recent fish. Gudger, E. W. 1915.1; Regan, C. T. Add. 1913.1.

Largest deep sea fish, Macrias amissus, is five feet in length. Gill, T. N. & Townsend, C. H. 1901.1.

Miscellanea. — *Environmental conditions determining size.* Chudeau, R. 1898.1. *Dwarf races of Coregonus.* Klunzinger, C. B. 1900.1. —*Dwarfed forms among Swedish fishes.* Lönnberg, A. J. 1902.8. — *Dwarfed muskalonge.* Sterling, E. 1877.1. — *Relation of size to saline content of sea.* Anon. 497. — *Absolute and relative weights of viscera.* Bellingeri, C. F. Add. 1849.1. — *The maximum size of fishes and its causes.* Prince, E. E. Add. 1904.2.

RECORDS OF SIZE

Unquestionably numerous additional records of large size of fishes will be disclosed by search through the literature. The following references are for the most part those which indicate by their titles that they refer to large specimens.

Large specimens recorded as follows

ELASMOBRANCHII

Carcharias. Bennett, G. 1859.1. — *Sphyrna (12.5 ft.).* Gudger, E. W. 1907.1; Welsh, W. W. 1916.1. — *Pristis (16 ft.).* Shields, S. A. 1879.1.

A weight of 4000 pounds for a specimen of Carcharodon carcharodon, taken in the Mediterranean, is given by Bonaparte, C. L. 1839.1.

Speculations on the probable length of the largest of all fishes, the shark Carcharodon megalodon, known only from fossil teeth. Bowerbank, J. S. 1852.1; Dean, B. 1909.1; Hussakof, L. 1912.2.

GANOIDEI

Polyodon. Hussakof. L. 1911.3.

Lepidosteus tristœchus. Shufeldt, R. W. 1903.9.

See also C. H. Townsend, "Giant Gars from Louisiana" *in* Bull. N. Y. Zool. Soc. 1920, vol. 23, pp. 119–120.

TELEOSTEI

Large specimens of the carp. Chion, – 1838.1; Garman, S. 1889.2; Grube, A. E. 1866.1; Häfeli, – 1802.1; Lavenier, – 1895.1; Mackrill, A. 1884.1.

Large specimens of the cod. Baird, S. F. 1872.18; Lönnberg, A. J. 1907.4; Smith, Everett, 1883.1.

Large specimens of the pike (Esox). Baird, S. F. 1872.1, 1875.21; Gurney, J. H. (*46 in. long*) 1875.1; Hintze, A. 1897.1; Jardine, A. Add. 1898.1. — *Probable weight of seventy-two lbs. for the giant pike of Loch Ken of Scotland.* Regan, C. T. 1911.9.

Large specimens recorded as follows: —*Epinephelus.* Alcock, A. W. 1905.1. — *Stereolepis.* Boulenger, G. A. 1897.9. —*Eel.* Cornish, T. 1872.4; Anon. 363 (*36 lbs.*). — *Halibut (Hippoglossus).* G., N. 1877.1. — *Thymallus.* Hintze, A. 1893.2. — *Gasterosteus (82 mm.).* Levander, K. M. 1900.2. —*Lota.* Nordqvist, O. F. 1904.4. — *Trout.* Pellegrin, J. 1900.9. —*Bluefish (Pomatomus).* Smith, H. M. 1903.1. —*Brook trout.* Sterling, E. 1875.1. — *Conger (53 lbs.).* Sweetapple, E. 1869.1. —*Bream (Abramis) (15 lbs.).* Zur Mühlen, M. 1911.2.

Large specimens of the "Mahaseer" (Barbus mosal), of mountain streams of India and Ceylon. Kinnear, N. B. 1910.1; Murray-Aynsley, C. E. 1910.1; Wallenger, W. A. 1908.1; Willey, A. 1903.1; Skene Dhu Add. 1906.1.

Records of large specimens of the ocean sunfish, Orthagoriscus mola. Mikhaĭlovskiĭ, M. M. 1903.1; Nardo, G. D. 1841.1; Stearns, R. E. 1867.1; Dean, B. Add. 1913.2.

A table comprising the ★ "World's record catches with rod and reel and otherwise of 60 North American popular fresh and salt water fishes" has been compiled recently by J. T. Nichols *and* Van Campen Heilner, *and published in* Field and Stream, July, 1920, pp. 268–269.

Smallest specimens on record

Of various fishes, whose developmental history is not known, the smallest known specimens have been recorded as follows: — *Polyodon.* Barbour, T. 1911.1; Danforth, C. H. 1911.1. — *Remora.* Daldorf, D. C. Add. 1793.1.

GUSTATORY ORGANS

For the functions of these organs, *see* Taste.

Anatomy in — *Cyprinus.* Beneden, P. J. 1835.1; Fohmann, V. 1835.2; Weber, E. H. 1827.7. — *Teleostei.* Jourdan, E. 1881.1. —*Elasmobranchii.* Nardo, G. D. 1846.2, 1851.1; Todaro, F. 1872.1, 1873.1, Add. 1873.1.

Miscellaneous and general. Duméril, A. M. 1858.1; Herrick, C. J. 1904.1; Schulze, F. E. 1868.1.

Taste buds. *Structure, origin, nerve terminations in, etc.* Dogiel, A. S. (*Ganoidei*) 1897.1; Johnston, J. B. 1909.2; Lenhossék, M. 1892.2.

Structure and distribution of taste buds in — *Cottus.* Maehrenthal, F. C. 1892.1. — *Petromyzon.* Retzius, M. G. 1893.4. — *In mouth, Lophius.* Guitel, F. 1891.2,.5. — *In skin of head and barbels of Ameiurus and hake.* Herrick, C. J. 1903.2; Landacre, F. L. 1907.1.

HABITS OF FISHES

For the breeding habits of fishes comprising courtship, spawning behavior, parental care, nest-building, oral gestation, viviparity, etc., *see under* Reproduction.

For the "intelligence" of fishes comprising their comparative psychology, and for technical studies on habit formation, etc., *see under* Behavior.

For the living together or association of fishes with other fishes, or with invertebrates, *see under* Commensalism and symbiosis.

For accounts of sharks attacking men, swordfish attacking whales, etc., *see under* Predatory fishes.

See also under such related topics as Aestivation; Food of fishes; Hibernation; Locomotion; Migrations; Parasitic fishes; Sleep of fishes; etc.

References to the life-histories, etc., of particular fishes will be found under the various families and genera to which they refer.

Chiefly miscellaneous and unclassified items on the habits of fishes. Abel, O. 1907.1; Aflalo, F. G. 1902.2, 1904.2; Baird, S. F. 1876.8; Beckford, F. J. 1897.1; Beckmann, J. 1769.1; Blake, J. H. 1870.1; Blanchard, C. E. 1866.1; Carter, R. 1884.1; Coles, R. J. 1910.1; Coste, P. 1858.1; Dollo, L. 1895.1; Ehrenbaum, E. 1909.2; Gray, J. E. 1861.1; Groos, R. 1902.1; Huet, P. 1904.1; Nusbaum, J. 1880.1; Osburn, R. C. 1913.2; Selous, E. 1911.1; Shufeldt, R. W. 1902.2; Smith, T. 1806.1; Tosh, J. R. 1903.1; Verrill, A. E. 1871.2.

GENERAL ACCOUNTS OF THE HABITS OF VARIOUS FISHES

Comprising general and inclusive articles dealing with the unspecified habits of fishes.

CEPHALOCHORDATA

Habits of Amphioxus. Gage, S. H. 1905.1; Rice, H. J. 1880.1.

ELASMOBRANCHII

Habits of Mobula. Coles, R. J. 1910.1; Gill, T. N. 1908.5. —*Selachii.* Duméril, A. H. 1865.4. —*Scyllium.* Geoffroy-Saint-Hilaire, E. F. 1808.1. —*Rhineodon,* Gill, T. N. 1905.11.

DIPNOI AND GANOIDEI

Habits of Amia and Lepidosteus. Locke, W. M. 1878.2, 1879.4. —*Lepidosteus.* Mark, E. L. 1890.1. —*Ceratodus.* Macleay, W. 1883.5; Semon, R. W. 1896.2, 1899.1, 1903.1, 1908.1, Add. 1893.1,.2; Spencer, W. B. 1892.1, Add. 1892.1.

TELEOSTEI

Sub-order Acanthopterygii

Gobiiformes. —*Habits of Periophthalmus.* Bean, B. A. 1889.6; Livingstone, D. & Livingstone, C. Add. 1866.1; Woodford, C. Add. 1890.1. —*Sicydium.* Clark, Austin H. 1905.1. —*Cyclopterus.* Gill, T. N. 1907.3.

Jugulares. —*Habits of Batrachus.* Appun, K. F. 1870.1. —*Uranoscopus.* Facciolà, L. 1883.1. —*Anarrichadidæ.* Gill, T. N. 1911.2. —*Opsanus.* Gudger, E. W. 1910.1. —*Trachinus.* Dunn, M. Add. 1885.2.

Perciformes. —*Habits of Aphredoderus.* Abbott, C. C. 1862.2, 1872.2. —*Perca flavescens.* Abbott, C. C. 1876.1. —*Enneacanthus and Mesogonistius.* Abbott, C. C. 1884.2. —*Labrax.* Akers, G. F. 1879.1. —*Mullus.* Couch, J. 1869.1. —*Centrarchidæ.* Mather, F. 1884.4. —*Micropterus.* Tisdale, S. T. 1871.2. —*Ruvettus.* Becke, L. Add. 1897.1, 1909.1. —*Capros.* Cunningham, J. T. Add. 1888.1.

Scleroparei. —*Habits of Cottus.* Bade, E. 1899.4; Gill, T. N. 1908.2. —*Myoxocephalus.* Gill, T. N. 1905.15. —*Liparis.* Smith, W. A. Add. 1885.1.

Scombriformes. —*Habits of Scomber.* Allen, E. J. 1897.3; 1909.1; Cunningham, J. T. 1902.2. —*Lepidopus.* Robson, C. H. 1876.1, 1884.2.

Zeorhombi. —*Habits of Pleuronectes.* Ascroft, R. L. 1900.2; Bean, T. H. 1878.6. —*Hippoglossus.* Atwood, N. E. 1865.1, 1869.2, 1871.1.

Sub-order Apodes

Habits of Anguilla. Baird, S. F. 1875.16; Caumont, A. 1858.1; Dean, B. 1912.2; Desmarest, E. 1866.1; Friedel, E. 1871.3; McGovern, H. D. 1881.1; Olivier, E. 1910.1; Roosevelt, R. B. 1878.3,.4; Anon. 275.

Sub-order Haplomi

Habits of Umbra. Abbott, C. C. 1875.2. —*Esox.* Curtis, G. 1861.1. —*Anableps.* Le Conte, J. L. 1861.1; Smith, J. P. G. 1850.1; Beebe, M. B. & Beebe, C. W. Add. 1910.1.

Sub-order Malacopterygii

Habits of Thymallus. Ainsworth, S. H. 1874.1; Rutland, J. 1878.1. —*Pomatomus.* Ayres, W. O. 1852.1. —*Mallotus.* Atwood, N. E. 1871.1, —*Alosa.* Barfurth, D. 1874.1, 1876.1; Chapman, P. 1875.1. —*Herring.* Chapman, P. 1875.1. —*Pilchard.* Cornish, T. 1883.1. —*Osteoglossum.* Haseman, J. D. 1911.2. —*Coregonus.* Milner, J. W. 1877.1.

Sub-order Ostariophysi

Habits of Gymnotus. Bradley, T. 1838.1; ★Sachs, C. 1877.1, 1881.1. —*Phoxinus.* Bruyant, C. 1898.1. —*North American Siluridæ.* ★Kendall, W. C. 1904.1, 1910.1. —*Tinca.* Lunel, G. 1874.2. —*Ameiurus.* Sainville, E. 1908.1. —*Carassius.* Stratton, H. Add. 1833.1.

Habits of Teleostean fishes of various other sub-orders

Hemiramphus. Andrews, W. 1849.3. —*Orthagoriscus.* Binney, A. 1842.1. —*Belone.* Cunningham, J. T. 1902.2. —*Syngnathus.* Gray, J. E. 1861.1. —*Merluccius.* Nye, W. jr. 1887.2. —*Antennarius.* Whitmee, S. J. 1875.1. —*Gadidæ.* Atwood, N. E. 1866.1,.2.

For further data on habits of fishes, see under Natural History *under the fish in the* Systematic section.

VARIOUS SPECIFIC HABITS

For specific habits treated elsewhere, see cross-references at the beginning of this section.

Habits — *Cont'd.*

Burrowing habits

Rissola marginata. Gill, T. N. 1905.9; Gudger, E. W. 1905.3. — *The "Bora Chung," Bootan, India.* Pearson, J. T. 1840.1; Campbell, A. Add. 1842.1. — *Zeugopterus.* Richardson, J. 1860.2. — *Astroscopus.* Dahlgren, U. Add. 1914.3.

See also in this connection the sections on Aestivation *and on* Hibernation.

Fighting habits of Betta pugnax

Boulenger, G. A. 1904.7; Cantor, T. E. 1849.1.

For a late account, see F. H. Stone *in* Journ. Bombay Nat. Hist. Soc., 1914, vol. 22, pp. 632–633.

Other accounts will probably be found under Betta *in the section* Aquarium Fishes.

Habits of Inflation

Tetrodon. Jackson, J. B. S. 1848.1; Sørensen, W. E. 1883.1. — *Diodon.* Pycraft, W. 1903.1.

For a general account (with illustrations) of this habit among Gymnodontes, see E. W. Gudger *in* Bull. N. Y. Zool. Soc. 1919, vol. 22, pp. 126–131.

Cephaloscyllium. Jordan, D. S. & Gilbert, C. H. 1880.36.

Water-throwing habits of the archer-fish, Toxotes

Brehm, A. E. 1883.1; ★Gill, T. N. 1909.2; Hommel, – 1777.1; Schlosser, J. A. 1764.1, 1777.1; ★Zolotniskiĭ, N. F. 1902.1,.2; Beccari, O. Add. 1904.1; D'Argenville, A. J. Add. 1767.1; Jacobs, T. J. Add. 1884.1.

For additional accounts, see P. Nitsche "Der Schützenfische (*Toxotes jaculator*)" Natur u. Haus, 1899, vol. 8, 22–25; *and* Lampert, K. *Idem.*, 1899, vol. 8, 43–44.

Disbelief of alleged archer-feats; Chelmon rostratus considered true archer-fish. ★Day, F. 1881.4.

Similar water-throwing habit in other fishes. Townsend, C. H. Add. 1909.1.

HEAD

For the structure and relationships of the mouth, *see* Oral cavity *under* Alimentary Canal.

For the musculature of the head, *see* Cranial and visceral muscles *under* Myology.

For the external open sac of the olfactory organ, *see* Nares *under* Olfactory organs.

For the bony framework of the head, *see* Skull.

For an outstanding treatise on the morphology and development of the head, see ★Locy, W. A. **1895.1.**

Embryology and development

General papers. ★Ayers, H. 1891.1; Froriep, A. 1902.2; His, W. 1894.2; ★Kupffer, C. W. 1893.3, 1896.1; Minot, C. S. 1897.1.

Development of the head in Cyclostomata. — *Petromyzon.* ★Koltzoff, N. K. **1902.1**; Kupffer, C. W. 1893.1 (ii, iii) — *Bdellostoma.* Kupffer, C. W. 1899.2.

Development in Selachii. ★Froriep, A. 1901.1; Hoffman, C. K. 1894.1.

Development of the head in — *Neoceratodus.* ★Greil, A. **1908.1**, 1913.1 — *Acipenser.* ★Kupffer, C. W. 1891.2, 1893.1 (i); — *Gobius.* Pollard, H. B. 1894.2.

"Cirrhostomial" origin of the head. Pollard, H. B. 1894.1, 1895.1; — *Phylogenetic origin.* Ziegler, H. E. 1908.2.

Metamerism of head

Most of the references given below under Morphology include also Metamerism. In this connection, *see also* Embryo formation *and* Medullary tube *under* Embryology.

General researches on metamerism of the head. Dohrn, F. A. 1890.1; ★Hatschek, B. 1906.1, 1909.1, 1910.1; Hill, C. 1899.1, Add. 1900.1; Locy, W. A. 1897.1; Neal, H. V. 1898.1; Rabl, C. 1892.2; ★Severtzov, A. N. 1895.1; Wijhe, J. W. 1886.2; Kingsley, J. S. Add. 1896.1.

Metamerism of the head from the standpoint of the nervous system. Hawkes, O. A. 1905.2; ★Johnston, J. B. 1905.3; Neal, H. V. 1898.2; Stockard, C. R. 1908.1.

Metamerism of the head in Cyclostomata (Petromyzon). Kolikov, N. K. 1901.1, Add. 1899.1; Koltzoff, N. K. 1899.1; Neal, H. V. 1915.3.

Metamerism in Selachii. ★Brohmer, P. 1909.1; ★Dohrn, F. A. 1882.2 (xv, xviii, xxi, xxii); Killian, G. 1891.1; ★Severtzov, A. N. 1898.1,.2, 1899.2; Locy, W. A. Add. 1895.1; Matveev, B. Add. 1914.1.

Morphology of head

Miscellaneous and general papers on the morphology of the head of vertebrates including fishes. Ayers, H. 1890.1; Chaine, J. 1905.1; Froriep, A. 1902.1; Hilgard, T. C. 1857.1; Marshall, A. M. 1879.1; Neal, H. V. 1898.1; Norris, H. W. 1891.1; MacMurrich, J. P. Add. 1884. 1.

Morphology of the head of various fishes. — *Scomber.* Allis, E. P. 1903.4. — *Embryo of Chlamydoselachus.* Brohmer, P. 1909.1. — *Dipnoi.* Fürbringer, K. 1904.3. — *Pristis and Pristiophorus.* Hoffmann, L. 1912.1. — *Amphioxus.* Wijhe, J. W. 1901.1. — *Acanthias,* Platt, J. B. 1891.1,.2. — *Macruridæ.* Pfüller, A. 1914.1.

Anterior head cavities; structure and development, chiefly in Selachii. Boeke, J. 1903.1; Marshall, A. M. 1881.1; Platt, J. B. 1890.1; Reighard, J. E. 1901.1. — *Chlamydoselachus and Spinax.* Brohmer, P. 1909.1.

For the development of the head mesoblast, see under Mesoderm *in section on* Embryology.

Snout of fishes. Pereyaslavtzeva, S. 1876.1. — *Occipital region of Trutta.* Willcox, M. A. 1899.1. — *Face of fishes, comparative anatomy.* ★Winther, G. P. 1875.2, 1877.1.

Structure and biological significance of the "saw" of Pristis and Pristiophorus. Kölliker, R. 1860.5; Pappenheim, P. 1905.5.

For Frontal gibbosity, a swelling or protuberance on the heads of certain male fishes, *see under* Sexual dimorphism.

HEARING AND THE STATIC SENSE

Comprising the functions of the membranous labyrinth or ear.

For the morphology of the membranous labyrinth, *see under* Auditory organs.

For a complete résumé of the literature on hearing and the static sense in fishes, see ★Mangold, E. Add. **1912.1.**

HEARING

Or the sense of audition

It has not yet been conclusively demonstrated that all fishes react to sound-waves.

Kreidl noted no reactions in goldfishes from vibrating rods held both in air and water, except when the fishes had been made more sensitive by strychnine and then the reactions took place even with the ear removed. It has, however, since been objected by Bigelow that the *entire* ear was not removed.

Parker (1904.2), experimenting with Fundulus and using the sustained slow vibrations of a bass viol string, observed reactions (fin movements) in only 18 per cent of fishes when the auditory nerves were cut, but in 94 per cent when the ears were intact and the skin insensitized. He thus definitely concluded that fishes react to sound waves.

Zenneck working with Alburnus and Leuciscus concluded that fishes *do hear.* He used an electric bell under water and noted activity when the bell was rung and sound-waves produced but inactivity when a piece of leather placed under the clapper of the bell inhibited the sound waves and produced mechanical vibrations instead. Bernoulli, repeating these experiments with eels and trout, obtained only negative results.

Hearing in fishes considered impossible on grounds of brain structure. Edinger, L. 1908.2.

Researches on detached heads of pike; on receiving stimulus of sounds through water, the otolith organ shows an increase of electronegativity indicating momentarily active condition of the nerve and accepted as showing possibility of hearing. ★Piper, H. Add. 1906.1, 1911.1.

Evolution of hearing in vertebrates. Willem, V. Add. 1913.1.

Investigations *of a technical or scientific nature on the sense of hearing in fishes.* Bernoulli, A. L. 1910.1; Bigelow, H. B. 1904.1; Haempel, O. 1911.1; ★Körner, O. 1905.1; ★Kreidl, A. 1895.1, Add. 1896.1; Lafite-Dupont, J. 1907.1; Lee, F. S. 1898.1; Maier, H. N. 1909.1; Marage, – 1906.1; Nollet, – 1813.1; ★Parker, G. H. 1903.3, 1904.2, 1909.3; 1910.4; Zenneck, J. 1903.1, 1904.1.

Hearing in the blind cave-fish, Amblyopsis. Eigenmann, C. & Yoder, A. 1899.1; Payne, F. 1909.1.

Effects of explosive sounds. Parker, G. H. 1913.1; Zur Mühlen, M. 1911.26.

Sound as a directing influence in movements. Parker, G. H. 1910.2, 1912.2.

Movements of eye determined by hearing. Kubo, I. Add. 1906.1.

Observations, *including anecdotes, miscellaneous notes, records, etc., recording the belief of their writers that fishes possess the ability to hear.*

Text in English. Baker, A. F. 1876.1; ★Bateson, W. 1889.1; Bell, J. C. 1904.1; Clapham, T. 1878.1; Lockington, W. N. 1879.3; Mackintosh, H. W. 1876.1; Redding, B. B. 1879.5.

Text in German. Beer, T. 1896.1; Blochmann, F. 1903.1; Brüning, C. 1906.1; Lang, A. 1902.1; Lenz, E. 1906.1; Piper, H. 1906.1; Plehn, M. 1905.2; Reeker, H. 1898.1; Roth, W. 1910.1; Simroth, H. R. 1897.1; Sprenger, W. 1900.5; Zacharias, E. O. 1906.1; Anon. 553; Hensen, V. Add. 1904.1; Meyer, M. Add. 1909.1; Reinhart, H. Add. 1913.1.

Texts in other languages. — *Dutch.* Baster, J. 1762.2. — *Italian.* Ducceschi, V. 1903.1. — *French.* Geoffroy-Saint-Hilaire, E. 1824.3,.10. — *Hungarian.* Gorka, S. 1906.1. — *Swedish.* Iverus, I. E. 1899.1. — *Norwegian.* Møllers, H. T. 1865.1. — *Spanish.* Rivera, E. 1905.1. — *Latin.* Camper, P. Add. 1763.1.

Early references, in Pre-Linn. *section.* Arderon, W. 1750.1; Brockelsby, R. 1750.1; Camper, P. 1756.1; Denso, J. D. 1756.1; ★Klein, J. T. 1740.1–1747.1; Maurer, F. 1713.1; ★Nollet, J. A. 1746.1; Seger, G. 1688.1.

STATIC SENSE

Or maintenance of equilibrium

Including the perception of progressive movements and of position in space.

For Hydrostatic equilibrium, *see under* Air bladder.

For a related subject, *see* Locomotion.

The functions of the lateral line organs are intimately related to the general subject of hearing. For references, *see under* Lateral line system.

For a complete review of the literature on the static sense, see ★Mangold, E. Add. **1912.1.**

Breuer's theory of semicircular canals and otoliths as organs for sensations of acceleration of movement or for sense of rotation. ★Breuer, J. 1874.1, 1890.1.

Researches on the maintenance of equilibrium, the functions of the semicircular canals, and otoliths, etc., through the destruction or excision of the membranous labyrinth on either one or both sides, transection of the auditory nerves, etc. Ayers, H. 1894.1; ★Bethe, A. 1894.1, 1899.1; Carazzi, D. 1898.1; Cyon, E. 1878.1, 1900.1; Ewald, W. F. 1907.1; Fröhlich, A. 1904.1; Gaglio, G. 1902.1; Lafite-Dupont, J. 1905.1; ★Lee, F. S. **1894.1,** 1898.1; Monoyer, F. 1866.1,.2; Parker, G. H. 1910.1; Quix, F. H. 1903.1,.12; ★Sewall, H. 1882.1, 1884.1; Steiner, J. 1886.3, 1888.1; Chabry, L. M. Add. 1884.1; Kreidl, A. Add. 1892.1; Kubo, I. Add. 1906.1; Loeb, J. Add. 1891.2.

For effects of extirpation of canals and otoliths in the asymmetrical flounder, unfavorable to otolith hypothesis, see Lyon, E. P. *in* Amer. Journ. Physiol., 1899, vol. iii, pp. 98–104.

Hearing — *Cont'd.*

The ear as an organ for the perception of movements in the surrounding water. Tullberg, T. F. 1903.1.

Centers of localization of static sense in brain. Reisinger, L. 1915.1.

Effects of electric current on equilibrium. Alluaud, C. & Vlès, F. 1911.1.

Equilibrium considered due to fins. Gouriet, E. 1864.1, 1866.2; Houssay, F. 1909.1,.2, Add. 1912.1; Osburn, R. C. 1906.1.

Equilibrium considered due to action of both fins and air bladder. Müller, J. 1845.1.

The skin, lateral-line organs and ear as organs of equilibrium. ★Parker, G. H. Add. 1905.1.

HEART OF FISHES

For the other vascular organs, *see* Circulatory system.

For the coronary arteries and the lymphatics of the heart, *see under* Circulatory system.

For the " caudal heart," a pulsating lymph vessel, *see* Lymphatic system *under* Circulatory system.

Anatomy and morphology *of heart. For a general treatise on the comparative anatomy of the vertebrate heart, see* ★Röse, C. **1889.1.**

Miscellaneous and general. Braeunig, K. 1904.1; Döllinger, I. 1811.1; ★Dogiel, J. 1910.1; Gegenbaur, C. 1865.2; Hoyer, H. 1900.1; Hyrtl, C. J. 1859.2; Kerr, J. G. 1913.1; Marceau, E. 1902.1; Müller, J. 1845.4; Sabatier, C. P. 1873.1; ★Tiedemann, D. F. 1809.1; ★McWilliam, J. A. Add. 1885.1.

Anatomy of the heart in Elasmobranchii. François-Franck, C. A. 1913.1. — *Chimæra.* Lankester, E. R. 1879.1. — *Raja.* McQueen, J. M. 1913.1; Parchappe, M. 1848.1.

Morphology of heart in various fishes. — *Dipnoi.* Boas, J. E. 1880.1. — *Polyodon.* Danforth, C. H. 1912.1. — *Gadus.* Jourdain, S. 1867.2; Lubach, D. 1867.1. — *Teleosts.* Kasem-Beck, – & Dogiel, J. 1882.1; Keith, A. & Flack, M. 1907.1. — *Ceratodus and Protopterus.* Lankester, E. R. 1879.1. — *Acipenser.* Parchappe, M. 1848.1. — *Ammocœtes and Petromyzon.* Vialleton, L. 1903.1.

Internal structure of heart in Plagiostomes and Ceratodus (figures). Garman, S. 1913.1.

Development and embryology. *Special researches.* — *Cavity, manner of formation.* Ryder, J. A. 1885.10. — *First anlage.* Mollier, S. Add. 1906.1.

Development of heart in Cyclostomata. — *Petromyzon.* Hatta, S. 1897.1; Keiser, W. Add. 1914.1. — *Cyclostomes, Ganoids, Selachians.* ★Rückert, J. & Mollier, S. Add. 1906.1.

Development in Elasmobranchii. ★Hoffmann, C. K. 1892.1, 1893.2, Add. 1892.1; Mayer, P. 1887.1; Rückert, J. 1888.1. — *Raja.* Weber, A. 1908.1.

In Teleostei (and Lepidosiren). Borcéa, J. 1909.3; Mollier, S. 1906.2. — *Esox.* Aubert, H. 1855.1. — *Lepidosiren.* Robertson, J. I. 1913.1. — *Alosa.* Senior, H. D. 1909.1. — *Salmonidæ.* ★Sobotta, J. 1894.1, 1902.1. — *Lophobranchii.* Weber, A. 1906.1, 1906.4.

Histology and histogenesis *of heart. Elastic fibers.* Pogonowska, I. 1911.1; Gregory, E. H. Add. 1897.1; Schumacher, S. Add. 1898.1.

Endocardium, the epithelial lining of the heart, origin. Holbrook, A. T. 1894.1; Stricht, O. 1896.2.

Histogenesis of myocardium, heart-muscle, muscle-fibers, etc. Boeke, J. 1903.3; Gulliver, G. 1842.1; Macallum, A. B. 1897.1; Retterer, E. & Lelièvre, A. 1909.2; Schockaert, A. 1909.1; Stannius, F. H. 1853.1.

Innervation of the heart. *Distribution of nerve fibers, ganglia, etc.* Bottazzi, F. 1901.1; Sala, L. 1910.1; Vignal, W. V. 1880.1.

Cardio-regulatory nerves. — *Present in Ichthyomyzon.* Carlson, A. J. 1906.1. — *Absent in Bdellostoma.* Greene, C. W. 1900.1, 1902.1. — *Origin in brain.* Kreidl, A. 1899.1.

Cardio-regulatory nerves, chiefly the vagus, experimental researches on inhibition, etc. Cadiat, L. O. 1879.1; McWilliam, J. A. 1884.1; Mills, T. W. 1886.1; Hemmeter, J. C. Add. 1914.1,.2.

Physiology: experimental researches on heart action *in fishes.*

For a general treatise on the physiology of the heart of fishes, see ★Tschermak, A. 1909.1.

Results of experimentation on the heart action of — *Selachii.* Baglioni, S. 1906.2; François-Franck, C. A. 1913.1; Meyer, J. 1910.1. — *Bdellostoma.* Carlson, A. J. 1904.1. — *Teleostei.* Kasem-Beck, – & Dogiel, J. 1882.1; Knox, R. 1822.1; Kolff, W. M. 1907.1–1908.1; McWilliam, J. A. 1884.2, Add. 1884.1, 1885.1; Thesen, J. E. 1896.1.

Cardiac rhythm, general accounts. Bätke, H. 1898.1; ★Dogiel, J. 1910.1; Mills, T. W. 1886.1; Mines, G. R. 1913.3; Boyle, R. Pre-Linn. 1670.1.

Effects of temperature on heart action. Babák, E. & Hepner, J. 1912.1; Polimanti, O. 1911.4.

Various unclassifiable experimental physiological papers. — *Influence of spinal marrow.* Clift, W. 1815.1,.2, 1816.1. — *Vitality of heart in a shark.* Dawson, John, 1852.1. — *Influence of activity.* Mines, G. R. 1913.1. — *Continuation after asphyxiation.* Polimanti, O. 1914.1.

Effects of various reagents. — *Influence of urea, Selachii.* Baglioni, S. 1905.1, 1906.1. — *Dependence upon oxygen.* Loeb, J. & Wasteneys, H. 1912.2. — *Relation to electrolytes.* Mines, G. R. 1907.1, 1911.1. — *Relation to concentration of sea water.* Schively, M. A. 1893.1.

For the effects of saline solutions on cardiac activities, see Alkaline media *under* Physiology.

For the influence of poisons on the heart action, see Drugs, alkaloids, *etc., under* Physiology.

For methods of recording the action of the heart by electro-cardiography, see Technique and methods.

PARTS OF HEART

Chambers of the heart of fishes. *Bulbus arteriosus, anatomy and physiology.* Carlet, G. 1876.1; Favaro, G. 1911.1; Gegenbaur, C. 1865.2, 1866.2.

Conus arteriosus, anatomy and morphology in —Butirinus. Boas, J. E. 1879.1. *—General.* Favaro, G. 1911.1; Gegenbaur, C. 1891.1. *—Ceratodus and Protopterus.* Lankester, E. R. 1879.1. *—Megalops.* Senior, H. D. 1907.1,.2,.3. *—Selachii, Chimæroids and Ganoids.* Stöhr, P. A. 1876.1, 1877.1.

Sinus venosus, development and physiology. —Pulsation in Anguilla. Delchef, J. 1905.1. *—Development of walls.* Lafite-Dupont, J. 1910.1.

Truncus arteriosus. Development. Greil, A. 1903.1.

Ventricle, structure of. Rathke, M. H. 1826.2,.3.

Pericardium, *or pericardial sac. —Help in formation of "diaphragm."* Bertelli, D. 1898.1. *—Pericardial communication with peritoneum in Elasmobranchii.* Delaroche, F. E. 1808.1.

Valves, *structure, development, and action.* Favaro, G. 1911.2; Pettigrew, J. B. 1866.1.

HERMAPHRODITISM

The following summary accurately represents the existing state of knowledge with regard to hermaphroditism in fishes. There is no comprehensive treatise on this subject known to us and no other account contains more information than the present.

For the normal structure of the reproductive organs, *see under* Urinogenital system.

The occurrence of hermaphrodite genital glands in fishes (especially in the Teleostei) is widespread.

An illuminative summary of hermaphroditism in fishes, is ★Howes, G. B. 1891.1.

Other general accounts, with collations of records are Gemmill, J. F. 1912.1; Syrski, S. 1876.2; ★Weber, M. 1884.1.

Discussions of phylogenetic derivation of hermaphroditism. Howes, G. B. 1891.1; Masterman, A. T. 1895.2.

Miscellaneous or unclassified papers on hermaphroditism. Cori, C. J. 1906.2; Hoek, P. P. 1890.5, 1891.1; Lönnberg, A. J. 1897.1; Martens, E. 1879.2; Starcke, J. H. Pre-Linn. 1700.1.

Petromyzon, Anguilla, and Conger, thought to be hermaphroditic and self-fertilizing. Home, E. 1823.1.

While there are intergradations, the following two subdivisions may be maintained, namely Functional, and Teratological hermaphroditism.

Functional Hermaphroditism

Being normal in the forms mentioned, in that the functional production of both ova and spermatozoa takes place. It seems to be now generally accepted that in these forms, hermaphroditism is the regular mode of reproduction.

CYCLOSTOMATA

"Myxine glutinosa is a protandric hermaphrodite [anterior end of gonad (ovotestis) being male, and posterior, female]. Up to a body-length of about 32 or 33 centimeters, it is a male, after that time it produces ova." Nansen, F. 1887.1 (p. 29).

Cunningham concluded that young "females are nearly, but not quite always hermaphrodite, and that the testicular portion normally disappears as the eggs become more mature." Cunningham, J. T. 1887.4 (p. 73).

These conclusions were questioned and differently interpreted by Dean, B. 1899.6 (p. 227).

The subject has been reviewed and the original conclusions of Nansen maintained, by ★Schreiner, K. E. 1904.2.

Although denying protandric *hermaphroditism, Cole says, " every adult Myxine is hermaphrodite, but either predominantly male or female . . . [having] either a mature testis and a rudimentary ovary, or a mature ovary and a rudimentary testis."* Cole, F. J. 1905.2 (p. 324).

Similar conditions in the brook lamprey (Lampetra) are reported by Okkelberg, P. 1914.1, *who states "a juvenile hermaphroditic condition occurs normally" and that "all the hermaphrodites develop into males."*

Of forty-nine larval forms of Petromyzon examined, one-fourth showed hermaphroditic characters, according to Lubosch, W. 1903.1.

The occurrence of a characteristic ovum among the spermatozoa in the testis of lampreys (Petromyzon), has been independently noted by Beard, J. 1893.1, *and* Ward, R. H. 1897.1.

J. L. Conel (Journ. Morph. 1917, vol. 29, p. 133) *after studying the urinogenital system believes it " impossible that Myxine can be a protandric hermaphrodite."*

TELEOSTEI

Serranus cabrilla, S. hepatus, and S. scriba, described as being functionally hermaphroditic, and self-fertilising through the simultaneous expulsion of ova and sperm. Dufossé, A. 1854.1. *These (anatomical) observations seem to be corroborated by* Brock, J. 1878.1 (p. 568).

In Chrysophrys auratus (Sparidæ), invariably hermaphroditic, the male and female genital products ripen alternately. Brock, J. 1878.1.

Protandrous hermaphroditism suggested for the cyprinid, Scardinius erythrophthalmus. Stéphan, P. 1901.1. *—Comment on this.* Roule, L. 1902.3.

Hermaphroditism — *Cont'd.*

Teratological Hermaphroditism

In these forms, hermaphroditism is only occasionally met with and is thus an abnormal or teratological condition.

As contrasted with conditions in other groups of vertebrates where "the dominant condition is that of replacement of one of the two testes in an ovary, or vice versa, in the Teleostei it is that of differentiation of the same gland into organically continuous ovary and testis." Howes.

Recorded instances of hermaphroditism, in the fishes listed below.

In general, the literature is limited to anatomical descriptions. Actual expulsion of both sperm and ova from the same individual has to our knowledge not been observed, although it doubtless occurs.

A few older records additional to these will be found in ★Weber, M. 1884.1.

CEPHALOCHORDATA

Of twenty-five gonads on the left side of an Amphioxus, one is an ovary and all others are testes full of sperm. Goodrich, E. S. 1912.1, 1913.1.

A male specimen of Amphioxus with forty-three gonads shows one, the fifth anterior left gonad, containing ova. Orton, J. H. 1914.1.

Langerhans stated that he detected the tails of sperm among the ovarian ova of Amphioxus. Langerhans, P. 1876.2 (p. 326).

SELACHII

A female specimen of Raja clavata presented a small testis on the left side. Hoek, P. P. 1894.1.

A female of Scyllium stellare showed on the right side a testis without a duct. Vayssière, A. & Quintaret, G. 1914.1.

TELEOSTEI

Burbot (Lota); recorded cases of hermaphroditsm. Järvi, T. H. 1909.3,.4; Luther, A. F. 1909.2; Pipping, J. G. 1800.1; Sandman, J. A. 1909.2; Schneider, G. 1903.13.

Carp (Cyprinus carpio). Jäckel, A. J. 1867.1; Alischer, S. Pre-Linn. 1720.1; Brückmann, F. E. Pre-Linn. 1734.1; Morand, S. Pre-Linn. 1740.1. Schwalbe, – Pre-Linn. 1734.1.

Eel (Anguilla); alleged hermaphroditism. Ercolani, G. B. 1871.1–1872.2; Nardo, G. D. 1871.2; Anon. 7.

Gadidæ; hermaphroditism recorded in the —Cod (Gadus morrhua). Halbertsma, H. J. 1864.1; Hefford, A. E. 1907.2; Hoek, P. P. 1890.4; ★Howes, G. B. 1891.1; Masterman, A. T. 1895.2; Smith, John A. 1867.9, 1870.1; Williamson, H. C. 1906.2. —*Whiting (G. merlangus).* Debierre, C. 1887.1. —*Ling (Molva vulgaris).* Kyle, H. M. 1897.1. —*Haddock (G. æglefinus).* Smith, W. R. 1891.2.

Herring (Clupea harengus); cases of hermaphroditism. Freund, L. 1909.1; Malm, A. W. 1865.2, 1873.1, 1877.3,.4; ★Münter, J. A. 1877.1; Pidgeon, D. 1898.1; Sandman, J. A. 1906.6; Sjöberg, H. R. 1911.1; Smith, John A. 1870.1; Smitt, F. A. 1882.1; Southwell, T. 1902.2; Vogt, C. C. 1882.1; Yarrell, W. 1845.1; Langrand, E. Add. 1914.1.

Perch, chiefly Perca fluviatilis. Hermaphroditism recorded. Halbertsma, H. J. 1864.1; Hoek, P. P. 1890.5; Ivanzov, N. 1893.1; Skogman, A. 1910.1.

Salmonidæ, cases of hermaphroditism. Couch, J. 1868.1; Simpson, J. Y. 1839.1; Stewart, C. 1891.2.

Cases of hermaphroditism in —Shad (Alosa). Fowler, H. W. 1912.2. —*Rutilus.* Fuhrmann, O. 1909.2, 1910.1. —*Sargus annularis.* MacLeod, J. 1881.2. —*Mackerel (Scomber).* Malm, A. W. 1873.1, 1874.4, 1877.3,.4; Stewart, C. 1891.1 —*Fundulus majalis.* Newman, H. H. 1908.2. —*Mugil.* Orlandi, S. 1902.1. —*Neomœnis and Ocyurus.* Poey, F. 1870.2. —*Gasterosteus.* Schneider, G. 1904.16. —*Sargus and Smaris.* Stéphan, P. 1902.1.

HIBERNATION

Hibernation or winter sleep, the torpid condition in which fishes survive the low temperatures and lack of food during winter.

Miscellaneous. Carradori, G. 1797.1; Cunisset-Carnot, – 1909.1; Schubart, A. 1913.1; Sundvik, E. E. 1895.1; Zuntz, N. 1905.1; Anon. 728. —*Due to environmental conditions in winter.* ★Knauthe, K. 1899.1.

Hibernation of various fishes. —*Carp.* Borodin, N. A. 1906.2; Supino, F. 1911.1, .2. —*Black bass.* Henshall, J. A. 1885.1. —*Hippocampus.* Rusconi, M. 1819.1.

For the manner in which fishes endure the dry season of tropical countries, see Aestivation.

HISTORICAL MATTER

For Historical matter concerning specific subjects, *see under such topics as* Fisheries, Pisciculture, etc.

For the history of ichthyology, *see under* Ichthyology.

For reproductions of ancient figures of fishes, *see* Iconography.

For legends, superstitions, etc., *see under* Mythology.

For fishes of the Bible, *see* Theology.

For a valuable recent work in English, treating of the part played by fishes and fishing in the economic and religious life of the Greeks and Romans, Egyptians, Assyrians, Jews, and Chinese, see ★Wm. Radcliffe. "Fishing from the earliest times." London. 1921. 478 p. ills.

Animals mentioned in "Don Quixote." Colmeiro y Penido, M. 1895.1. —*The earliest mention of fossil fishes.* Eastman, C. R. 1904.3. —*Old Arabic, Hebrew and German writings on anatomy.* Hyrtl, C. J. 1879.1, 1884.1. —*The animal lore of Shakespeare's time.* Phipson, E. 1883.1.

General treatises. *Histories of natural sciences from the earliest times to the present.* ★Carus, J. V. **1872.1**, 1880.1; ★Cuvier, G. **1841.1**; Dannemann, J. F. 1896.1; Haeckel, E. H. 1908.1; Jaeger, O. 1897.1; ★Locy, W. A. **1908.1**; ★Miall, L. C. 1911.1, **1912.1**; ★Osborn, H. F. **1894.1**; Spix, J. B. 1811.1; Wimmer, J. 1903.1, 1905.1; Woodward, B. B. 1905.1.

Greek and Roman ichthyology. *Three fishes of the ancients: Lucerna, Charax, and Hyaena.* Bouros, G. 1840.1. — *For Glanis of ancient Greeks and Romans, see* Parasilurus.

Natural history knowledge of the ancients. Eastman, C. R. 1905.4; Pleyel, J. 1905.1; Schneider, J. G. 1782.1, 1783.1; Schvarcz, G. 1862.1; Sophocles, E. A. 1860.1; ★Strunz, F. 1904.1; ★Voigt, G. **1893.1**; ★Lenz, H. O. Add. **1856.1**; Schneider, K. Add. 1892.1.

The Pre-Aristotelians. Mieli, A. 1916.1. — *Review of this.* Thompson, D. W. 1916.1.

Reference should be made in the Pre-Linn. *section to the following classical writers, most representative of their time.* Ælian, C. 1533.1; ★Aristotle. 1476.1; Arrian, F. 1508.1; ★Athenæus, N. 1514.1; Caesarius, J. 1518.1; Cassiodorus, M. A. 1579.1; Figulus, P. N. 1492.1; Homer. 1488.1; ★Oppian. 1478.1; Ovid 1471.1; ★Pliny, C. 1469.1; Pollux, J. 1608.1; Solinus, C. J. 1475.1; Suidas, – 1499.1; Theocritus. 1678.1.

Mediæval knowledge. *Popular treatises on science in the Middle Ages.* Moule, H. M. 1868.1; Pouchet, F. A. 1853.1; Wright, T. Add. 1841.1.

Bestiaries (MSS.) of the 12th and 13th Centuries. Morgan, J. P. 1906.1; Anet, C. Add. 1913.1. — *Codex Ricardiano, 1357.* McKenzie, K. 1905.1. — *Ecbasis captivi, 940.* Voigt, E. 1875.1.

Reference should be made in the Pre-Linn. *section to the following representative writers of the Renaissance.* Albertus Magnus 1478.1; Cardano, G. 1550.1; Cirino, A. 1653.1; Clusius, C. 1605.1; Freigius, J. T. 1579.1; Massarius, F. 1734.1; Musurus, M. 1515.1; Phile, M. 1533.1.

Modern period. *History of zoology.* — *In Austria, 1850–1900.* Steindachner, F. 1901.2. — *In America.* Wilson, H. V. 1912.1.

HYBRIDS AND HYBRIDIZATION

Among fishes, hybrids have been recorded only from the Teleostei.

For the short life of spermatozoa in water after their expulsion, which has been suggested as an adaptation for the prevention of hybridization, *see* Duration of virility *under* Spermatozoa.

For general treatises with enumeration of hybrids in all groups of animals (accounts of fishes rendered obsolete however by the present list), consult ★Ackermann, K. 1898.1; Day, F. 1890.1; *and* Suchetet, A. 1888.1 (*vol.* 24 *of Revue Q. S.*).

Cross-fertilization Experiments

Fertilization of ova with spermatozoa of remotely related forms. In general, development of such heterogenic hybrids ceases during cleavage stages.

Various experiments with marine fishes. Appellöf, A. 1894.1; Fulton, T. W. 1890.2; List, J. H. (*Labridæ*) 1887.1; McIntosh, W. C. 1891.3.

Individuality of maternal and paternal chromosomes in hybrids. Moenkhaus, W. J. 1903.2–1911.1; Morris, M. 1914.1; Hertwig, G. & Hertwig, P. Add. 1914.1.

Heredity of pigmentation in hybrids. Bancroft, F. W. 1911.1, 1912.1; Bataillon, E. 1900.7; Loeb, J. Add. 1898.1.

Heredity as exhibited by hybrids. Newman, H. H. 1908.1, 1910.1–1915.1.

A recent paper "The initial block to normal development in cross-fertilized eggs" *by* Edith Pinney, *relating experiments with eggs of Fundulus and reciprocal crosses between Ctenolabrus and Prionotus, appears in the* Journal of Morphology, 1922, vol. 36, pp. 401–415, 2 pls.

Genetical Work

The only researches on hybridizing fishes from the viewpoint of modern genetics, known to us, are the experiments with Pœciliidæ, *cited below under* ★Gerschler, M. W. Add. 1914.1–1914.3.

Some of the results of this work are discussed under Sex-determination *under* Embryology.

For various statistical "racial studies," which involve breeding experiments with fishes (Zoarces, Lebistes, and Salmo fario), consult the series by Johs. Schmidt, *in the* Journal of Genetics, 1918, *vol.* 7, *pp.* 105–118; 1919, *vol.* 8, *pp.* 147–153; 1920, *vol.* 9, *pp.* 61–67; 1920, *vol.* 10, *pp.* 179–191. *These are summaries of articles appearing in the* "Comptes-Rendus des travaux du Laboratoire Carlsberg, Copenhagen."

They tend to show that "racial characters" are of genotypical or hereditary constitution.

Hybrids in Cyprinidæ

Occurring under natural conditions except where noted. More hybrids have been recorded from this family than any other, and with few exceptions are European.

Faunal treatises including accounts of hybrids of Cyprinidæ. ★Fatio, V. 1882.1; Regan, C. T. 1911.8; Siebold, C. T. 1863.1; Smitt, F. A. 1893.1.

Miscellaneous papers on German hybrids of Cyprinidæ. Bade, E. 1904.1; Heincke, F. 1892.1; Knauthe, K. 1896.6, 1902.3, 1903.1; Leonhardt, E. E. 1903.1. —*Goldfish hybrids.* Lefebre, A. 1881.2; Stoll, A. A. 1907.1.

List of recorded hybrid forms, with names given them by systematists under the assumption that they were natural species:

Abramis brama × *Rutilus* (*Leuciscus*) *rutilus.* (*Abramis buggenhagii of Bloch; A. leuckartii of Heckel; Abramidopsis of Siebold*). — *Synonymy.* Fatio, V. 1882.1 (*p.* 347). — *A. leuckartii believed to be*

Hybrids — *Cont'd.*

hybrid of A. brama and Leuciscus sp. Kner, R. 1864.1. —*Occurrence in Germany and Finland.* Grube, A. E. 1867.1; Krauss, F. 1863.2; Luther, A. F. 1904.1; Stenroos, K. E. 1893.1, 1895.1; Westerlund, A. 1898.1.

Abramis melanops × *Rutilus rutilus.* (*Abramidopsis rhinosimus of Jäckel*). Jäckel, A. J. 1869.1.

Abramis brama × *Scardinius erythrophthalmus.* *"White roach" of Lough Erne, Ireland.* Regan, C. T. 1908.14.

Alburnus alborella × *Leuciscus cavedanus. From Lake Lugano.* Fatio, V. 1905.4.

Alburnus lucidus × *Leuciscus cephalus.* (*Alburnus dolobratus of Hollandre.*) *Synonymy.* Fatio, V. 1882.1 (*p.* 452).

Alburnus lucidus × *Leuciscus leuciscus. Recorded.* Leonhardt, E. 1904.15.

Alburnus lucidus × *Leucaspius delineatus. Artificially induced fertile hybrids* (*Alburnus leydigii*). Knauthe, K. 1893.2, .4, 1895.4.

Alburnus lucidus × *Rutilus rutilus. From R. Nene, England.* Günther, A. C. 1889.5.

Alburnus lucidus × *Scardinius erythrophthalmus. Alburnus rosenhaueri of* Jäckel, A. J. 1865.1, 1866.1. —*Scardinopsis alburniformis of* Benecke, B. 1884.1.

Blicca bjoerkna × *Alburnus lucidus.* (*Bliccopsis alburniformis of Siebold*). Jäckel, A. J. 1864.1–1866.1. —*Considered hybrid of B. bjoerkna and Abramis brama.* Knauthe, K. 1895.1.

Blicca bjoerkna × *Leuciscus meidingeri,* (*Bliccopsis melanopterus of Jäckel*). Jäckel, A. J. 1869.1.

Blicca bjoerkna × *Rutilus rutilus.* (*Abramis abramo-rutilus of Hollandre, Bliccopsis of Siebold*). —*Synonymy.* Fatio, V. 1882.1 (*p.* 387). —*Status.* Gensoul, J. 1908.2; Vutskits, G. 1907.1, 1913.1. —*Believed to be a hybrid between Abramis sp. and L. rutilus or S. erythrophthalmus.* Kner, R. 1864.1.

Blicca bjoerkna × *Scardinius* (*Leuciscus*) *erythrophthalmus.* (*Bliccopsis erythrophthalmoides of Jäckel*). Fatio, V. 1882.1 (*p.* 376); Jäckel, A. J. 1864.1; Knauthe, K. 1895.2. —*Occurrence in Finland.* Luther, A. F. 1901.1; Stenroos, K. E. 1895.1.

Carassius auratus × *Barbus conchonius. Artificially induced.* Leonhardt, E. E. 1905.21.

Cyprinus carpio × *Barbus vulgaris. Recorded.* Defay, – 1785.1.

Cyprinus carpio × *Carassius auratus. Artificially induced.* Fischer, F. 1880.1.

Cyprinus carpio × *Carassius vulgaris.* (*Carpio kollarii of Heckel*). —*Considered a distinct form, C. kollarii.* Heckel, J. J. 1836.3; Heckel, J. J. & Kner, R. 1858.1; Kner, R. 1864.1. —*Shown to be a hybrid.* ★Dybowski, B. J. 1864.1. —*Synonymy.* Fatio, V. 1882.1 (*p.* 198). —*Fertility.* Knauthe, K. 1893.4, 1895.4.

Cyprinus carpio × *Tinca vulgaris. Artificially produced.* Friedel, E. 1880.2 (*p.* 333).

Leuciscus agassizii × *Chondrostoma nasus.* (*Chondrostoma rysela of Agassiz*). —*Synonymy.* Fatio, V. 1882.1 (*p.* 724). —*Occurrence.* Murisier, P. 1911.1.

Leuciscus cephalus × *Chrondrostoma nasus. Description.* Fatio, V. 1882.1 (*p.* 706).

Leuciscus aula × *Scardinius erythrophthalmus. From Lago di Varano, Italy.* Bellotti, C. 1904.1; Chiappi; T. 1902.1.

Rhodeus amarus × *Leucaspius delineatus. Recorded.* Knauthe, K. 1896.1.

Rutilus rutilus × *Scardinius erythrophthalmus.* (*Scardiniopsis anceps of Jäckel*). Gensoul, J. 1908.2; Jäckel, A. J. 1864.1, 1865.1.

Hybrids in Pleuronectidæ

Alleged or supposed hybrids, chiefly existing under natural conditions.

Faunal treatises including accounts of supposed hybrids from Baltic and North Seas. Möbius, K. & Heinke, F. 1883.1; Smitt, F. A. 1893.1.

Pleuronectes limanda × *Pleuronectes flesus.* Day, F. 1885.7.

Pleuronectes platessa × *Pleuronectes limanda.* Duncker, G. 1892.2.

Pleuronectes platessa × *Pleuronectes flesus.* (*By artificial fertilization*). Kyle, H. M. 1900.4.

Pleuronectes platessa × *Rhombus maximus.* Krause, K. E. 1883.1.

Rhombus maximus × *Rhombus lævis* (*R. hybridus of Malm*). *Occurrence in nature, of turbot and brill hybrid.* Holt, E. W. 1893.3; Malm, A. W. 1877.2. —*Artificially produced.* McIntosh, W. C. 1891.3.

Hybrids in Pœciliidæ

Hybrids in these viviparous forms, produced through crossing aquarium fishes. Because of superfœtation, many former references to alleged hybrids are worthless.

Xiphophorus helleri × *Platypœcilus maculatus. Male Xiph.* (*strigatus*) *and female Platyp.* Haffner, C. 1912.4, 1913.1. —*Note on this.* Wolterstorff, W. G. 1913.1. —*The reciprocal cross; female Xiph. and male Platyp; back-crossing and other crosses.* ★Gerschler, W. M. Add. 1914.1–1914.3.

Pœcilia mexicana × *Molliensia latipinna. Male Pœcilia.* Scheljuzhko, L. 1912.1.

The citations (*partly oviparous forms*) *under* Fischer, M. 1911.1; Hey, F. 1910.1; Starkloff, C. 1913.1; *and* Thumm, J. 1905.1, *refer chiefly to the Blätter für Aquar. u. Terrar. Kunde. Search through this series should disclose additional alleged hybrids.*

Hybrids in Salmonidæ

With the exception cited below, of Salmo schiffermülleri occurring naturally in Austrian lakes, the numerous hybrids listed here have all been produced through artificial *fertilization by the fish-culturists. The Salmonidæ have always occupied their chief interest.*

The centers of such hybridization have been the experiments of Sir James Maitland at Howietoun recorded by Day and those of Seth Green of the New York hatchery, cited below and further recorded by R. B. Roosevelt in Proc. Amer. Assoc. Adv. Science, 1884, *vol.* 33, pp. 510–515.

Miscellaneous and unimportant items. Baird, S. F. 1873.18; Green, S. 1879.2, 1880.2,.4; Grieg, J. A. 1906.1; Hallock, C. 1873.5; Mather, F. 1876.6; Rasch, H. H. 1867.2; Smith, E. V. 1915.1; Anon. 387.

Experiments of Sir J. R. Gibson-Maitland at Howietoun, near Stirling, Scotland. ★Day, F. 1884.6, 1885.5,.8, 1887.1, 1888.1, **1890.1.** —*Notice of this work.* Behrens, G. 1885.1.

List of hybrid forms, all reared to maturity unless otherwise stated:

Oncorhynchus tschawytscha (milt) × Salvelinus fontinalis (eggs). Four-year old females developed eggs too large to void and evidently infertile. Green, S. 1882.1; Roosevelt, R. B. 1880.1, 1881.1.

Oncorhynchus sp. × Oncorhynchus sp. Crosses between various species, fry only. Richardson, J. A. 1906.1.

Salmo salar × Salmo fario. Infertile hybrids produced—at Hüningen, Alsace. Arens, C. 1894.1; Haack, H. 1880.6, 1894.1. —*at Winkelsmühle near Düsseldorf.* Overbeck, G. 1880.2.—*Review of these experiments.* Leuckart, C. G. 1882.1, .2. — *Three-year old hybrids developed eggs, in similar cross of Lochleven trout (eggs) and salmon.* Day, F. 1882.4, 1885.8.

Salmo fario × Lota marmorata. By artificial fertilization. Fraas, C. N. 1854.1.

Salmo fario × Salvelinus fontinalis. Lochleven trout eggs with brook trout milt. Hybrids fertile. Day, F. 1882.9, 1884.6, 1885.8.

Salmo fario (including Trutta lacustris) × Salvelinus salvelinus. — This cross first produced at Bärau near Gmunden, Austria. Kner, R. 1865.4. — *Produced at various localities in Germany and Russia.* Arens, C. 1893.1; Haacke, J. W. 1893.1; Knoch, J. Add. 1884.1. —*Salmo schiffermülleri Bloch, (Silberlachs) because of similarity of bred examples, considered a sterile hybrid possibly of this cross.* Fitzinger, L. J. 1875.1. — 1876.1.

Salmo fario × Salvelinus umbla. Crossed in France. Bruyant, C. 1910.1; Crettiez, J. 1906.1. — *This hybrid rec'd at U. S. Nat. Museum from Norway.* Bean, T. H. 1889.20, Add. 1889.1.

Salmo irideus × Salvelinus fontinalis. Sterile hybrids. Zalsman, P. G. 1914.1. —*Supposed hybrids from Wytheville station.* Bean, T. H. Add. 1889.1.

Salmo irideus × Salvelinus umbla. Rainbow trout eggs fertilized with milt of Ombre-chevalier. Crettiez, J. 1906.1.

Salvelinus alpinus × Salvelinus fontinalis. Scotch charr milt and Amer. charr eggs. Hybrids fertile but second hybrid generation died before maturity. Day, F. 1884.6,.8, 1885.8.

Salvelinus fontinalis × Salvelinus aureolus. Crossed at Sunapee L. hatchery. Hybrids fertile. Bean, T. H. 1910.8.

Salvelinus fontinalis × S. (Cristivomer) namaycush. Crossed at Corry station, Pa. Bean, T. H. 1889.3,.7,.9, 1890.32, Add. 1889.1. —*Fertile hybrids at N. Y. hatchery.* Green, S. 1880.2, 1882.1.

Various hybrid fishes

Chiefly of digeneric types, and occurring in nature unless otherwise stated.

Clupea pilchardus × Clupea harengus. Day, F. 1887.6.

Clupea alosa × Clupea finta. Believed to produce hybrids. Hoek, P. P. 1899.1.

Alosa sapidissima × Pomolobus pseudoharengus. Alleged appearance of adults in Hudson R. after planting of this cross. Roosevelt, R. B. 1881.1.

Alosa sapidissima × Roccus lineatus. Artificially produced. Ryder, J. A. 1883.1, 1887.2.

Salmo fario × Lota marmorata. Through artificial fertilization. Fraas, C. N. 1854.1.

Perca fluviatilis × Acerina cernua. Found in nature and also produced by artificial fertilization. ★Kammerer, P. 1907.2.

Gobio fluviatilis × Leuciscus phoxinus. Knauthe, K. 1891.1.

Chænobryttus gulosus × Lepomis gibbosus. Radcliffe, L. 1914.1.

Heros facetus × Geophagus gymnogenys. Schütz, R. 1912.1.

For hybrids between pike (Esox lucius) and pickerel (E. reticulatus), see G. C. Embody, *in* Journ. Hered. 1918, vol. 9, pp. 253–256, 2 pls. *Also* O. W. Smith, "The Book of the Pike," 1922, pp. 185–189.

ICHTHYOLOGY

For histories of natural sciences including ichthyology, *see* Historical matter.

Historical accounts. *Essays on the history of ichthyology.* Boulenger, G. A. 1910.3; Cuvier, G. & Valenciennes, A. 1828.1 (vol. 1); Günther, A. C. 1910.1; ★Jordan, D. S. 1902.5. — *Reprinted in* 1905.1; ★Lönnberg, A. J. 1901.5.

Development of American ichthyology. Gill, T. N. 1904.8; ★Goode, G. B. 1884.2, 1888.2; Lockington, W. N. 1882.2.

Works of a general nature

For compendia, dictionaries, encyclopedias, natural histories, works of a popular or non-technical nature relating to fishes, etc., *see the section entitled* General works on natural history.

For treatises on the fauna of a definite region, *see* the desired locality *under* Fauna of the world.

General works of a technical or precise nature: introductory studies, guides to studies, etc.

Text in English. ★Boulenger, G. A. 1895.2, **1904.7**; ★Bridge, T. W. **1904.1;** ★Dean, B. 1895.4; Gill, T. N. 1881.1, 1896.18, Add. 1881.1; ★Goode, G. B. 1888.1, 1903.1; Girard, C., Suckley, G. & Agassiz, L. 1857.1; ★Goodrich, E. S.

Ichthyology — *Cont'd.*

1900.1; Griffith, E. 1834.1; Günther, A. C. 1859.1, 1880.4, 1894.2, 1902.1; Jones, T. 1847.1; ★Jordan, D. S. **1905.1**, 1907.1; Monro, A. 1785.1, 1787.1; Richardson, J. 1856.1; Ward, Samuel, 1770.1, 1775.1, 1776.1; Wilson, J. 1838.1,.2.

Text in French. Ajasson de Grandsagne, J. B. 1828.1–1829.2; Auboin, S. 1831.1; ★Bloch, M. E. 1782.1, 1785.1,.2, 1786.1, 1801.1; Bonnaterre, J. P. 1788.1; Buffon, G. L. 1803.1; Castel, R. L. 1801.1; ★Cuvier, G. & Valenciennes, A. 1827.1, **1828.1**; Daubenton, L. J. 1782.1; Duméril, A. M. 1856.2; Duméril, A. H. 1865.3; Goüan, A. 1770.1; ★Lacépède, B. G. 1795.1, 1798.1, 1803.1, 1819.2, 1844.1, 1878.1; Sauvage, H. E. 1865.1; Sonnini de Manoncourt, C. N. 1803.1; ★Valenciennes, A. 1837.1, **1850.1**.

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Earlier works on ichthyology, *in* Pre-Linn. *section.* ★Aldrovandi, U. **1613.1**; ★Artedi, P. **1738.1**; ★Belon, P. **1551.1**, 1553.1; Bodin, J. 1555.1; Boussuet, F. 1558.1; ★Gesner, C. 1556.1, **1558.1**. 1563.1; Giovio, P. 1524.1, 1527.1; Klein, J. T. 1740.1; ★Rondelet, G. **1554.1**; ★Salviani, H. **1554.1**; ★Willughby, F. **1686.2**; Anon. 734, 757, 764.

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Comprising plates or illustrations of fishes.

For the fish symbol in art, *see under* Mythology and Symbolism.

See also Archæology, for ancient fish paintings, carvings, etc.

General collections. Bloch, M. E. 1786.1, 1787.1; Blumenbach, J. F. 1797.1; Buc'-Hoz, P. J. 1782.1; Kielsen, F. C. 1836.1; Lacépède, B. G. 1819.1; Richardson, J. 1843.2; Reichenbach, A. B. 1838.1; Rosenthal, F. 1812.1; Schmidt, K. 1820.1; Strack, – 1819.1; Swainson, W. 1820.1; Wagner, R. 1841.1; Anon. 503. — *Plates from Cuvier's "Animal Kingdom."* Comte, J. A. 1832.1; Guérin-Méneville, F. E. 1830.1.

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Pre-Linn. *refs. to early figures.* Albin, E. 1735.1; Collaert, A. 1580.1; Firens, P. 1616.1; Edwards, G. Pre-Linn. 1743.1; Flamen, A. B. 1664.1; Gesner, C. 1560.1; Meyer, J. D. 1748.1; Stradanus, J. 1578.1; Tempesta, A. 1600.1; Willughby, F. 1685.1.

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Austrian and German fishes. Redlefgmal, E. 1909.1; Schreiber, – 1913.1; Anon 386.

Fishing scenes. Refs. in Pre-Linn. *section.* Barlow, F. 1671.1; Bol, J. 1600.1; Coenen, A. 1577.1; Cornelius, G. 1662.1; Laan, A. 1700.1; Lonicer, J. A. 1582.1; Meulen, S. 1700.1.

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Asia. — *Illustrations of Indian zoology.* Gray, J. E. 1830.1. — *Collections of Chinese fish paintings by native artists.* Reeves, J. 1828.1; Anon. 135. — *Japanese fishes.* Anon. 742. — *"Dorades de la Chine."* Martinet, F. N. Add. 1780.1.

European fishes — from Austria and Germany. Redlefgmal, E. 1909.1; Meidinger, C. 1785.1; Weber, J. C. 1851.1; Anon. 771; Baldner, L. Pre-Linn. 1666.1. — *British fishes.* Whymper, C. 1897.1; Haecken, A. Pre-Linn. 1734.1. — *Scandinavian.* Kroyer, H. N. 1847.1. — *Italian fishes.* Salviani, H. Pre-Linn. 1554.1.

North American fishes. Agassiz, L. & Baird, S. F. 1889.1; Kilbourne, S. & Goode, G. Add. 1879.1.

South American fishes, chiefly Brazilian. Wallace, A. R. (n. d.) (*Rio Negro*). — Pre-Linn. *section.* Marcgrave, G. 1643.1; Mentzel, C. 1660.1; Post, F. 1643.1. — *Commentaries on Marcgrave's figures of Brazilian fishes.* Lichtenstein, M. H. 1818.1; Martius, C. F. 1853.1; Schneider, J. G. 1786.1.

South Sea fishes. — *Fishes collected by J. Banks.* Broussonet, P. Add. 1782.1. — *Sketches made during Capt. James Cook's third voyage.* Ellis, W. W. Add. 1776.1.

East Indian Fishes, Pre-Linn. *refs.,* Bruyn, C. 1718.1; Renard, L. 1718.1; Hooge, R. 1680.1; Anon. 773.

West Indian fishes. Pre-Linn. *section.* Catesby, M. 1750.1; Gautier d'Agoty, J. 1752.1; Hooge, R. 1680.1; Plumier, C. 1695.1. — *Identification of Catesby's figures.* Jordan, D. S. 1885.4.

INTEGUMENT OR SKIN (*OF FISHES*)

Although the integument properly includes the denticles and bony scales formed within the dermis, for the sake of convenience, the present section is limited to the soft tissues of the integument. The hard parts are treated under the heading " Dermal skeleton."

Likewise references to certain structures derived from the epidermis will be found elsewhere, such as Phosphorescent organs *under* Luminosity, *and* Poison glands *under* Poisonous fishes.

The integument in fishes, as in all vertebrates, consists of two layers, an outer *epidermis* (Oberhaut) consisting of the modified ectoderm, and an inner *dermis* or *corium* (Cutis vera, Lederhaut) composed of the outer or superficial layer of the mesenchyme which is modified mesoderm.

The dermis in fishes is thin and presents few distinctive features. It has in consequence not been the subject of extensive study. While many of the following references include the structure of the dermis, in general they refer chiefly to the epidermis.

Skin in general

Miscellaneous papers on the skin of Teleosts. Batelli, A. 1880.1; Leydig, F. 1851.1; Rathke, M. H. 1847.1.

Papers relating to the structure of the skin in the following Teleosts. — Muræna. Clark, A. 1849.1. — *Malapterurus.* Fritsch, G. T. 1886.1. — *Cyprinus.* Grunelius, A. 1913.1. —*Lophius.* Guitel, F. 1890.2. — *Cyclopterus.* Hase, A. 1911.2. — *Xiphias.* Nardo, G. D. 1841.2. — *Salmo.* Sacchi, M. 1887.1. — *Orthagoriscus.* Turner, W. 1862.1. — *Synodontis.* Vaillant, L. L. & Pettit, A. 1898.1. — *Ameiurus.* Wright, R. R. 1884.1.

In the blind fish Typhlogobius, there is " a highly abnormal development of blood-vessels in the sub-epidermal portion of the integument " obscuring the pigment layer and giving the living fish a pink color. This condition is presumably for the purpose of cutaneous respiration. Ritter, W. E. 1893.1.

No true metamerism is shown in the skin, such resemblances are due to muscular stresses. Grosser, O. 1905.1.

Transplantation of patches of skin from the uncolored ventral surface to the colored dorsal surface and vice versa in Nemachilus show no changes in color of the transplanted area until later immigration of chromatophores from surrounding areas and resorption takes place. Sécerov, S. 1912.1.

The skin of Anguilla, like other glandular structures, undergoes an excitatory variation as a result of electrical, thermic, and mechanical stimulation. Reid, E. W. 1894.2; Reid, E. W. & Tolputt, A. G. 1894.4.

Cutaneous sensory papillæ

In the blind fishes (Amblyopsidæ), the lack of eyes is compensated by the great development, especially on the head, of the cutaneous sensory papillæ. ★Eigenmann, C. H. 1909.2.

Although possessing eyes, the Gobiidæ likewise possess an extraordinary development of such cutaneous papillæ, whose arrangement is said by Sanzo to be of diagnostic value. ★Sanzo, L. 1911.1; Winther, G. P. 1874.4.

Nerve terminations in the epidermis. Fusari, R. 1901.1, 1907.1; Jobert, C. & Grandey, – 1870.1; ★Merkel, F. 1880.1; Retzius, M. G. 1892.4,.5; Schöler, E. 1885.1; Schulze, F. E. 1892.1.

For the epidermal sense organs (Hautsinnesorgane), see End organs *under* Senses and sense organs.

THE EPIDERMIS

The epidermis consists of two layers, a lower thick layer of actively dividing cells, the *stratum of Malphigi* and an outer layer of protective cells, the *stratum corneum,* which to replace wear is constantly renewed by division of the cells in the lower or Malphigian layer.

In various amphibians and reptiles this outer layer (periderm) is periodically shed as a whole but no such process occurs in fishes.

The most comprehensive general treatise (in German) on the epidermis, with a full bibliography is ★Studnička, F. K. **1909.1.**

Other older general treatises in German, are ★Leydig, F. 1879.1, *and* ★Maurer, F. 1895.1.

Probably the best summary in English of the literature on the epidermis of fishes is given in ★Reid, E. W. 1894.3.

Glandular elements

In correlation with their aquatic environment and in order to reduce surface friction by the secretion of mucus or " slime," the epidermis of fishes is generally rich in unicellular glandular structures.

Leydig (F. 1851.1), according to Reid (E. W. 1894.3), first demonstrated the possibility of a secretory process in the fish skin by the description of specialized cells in the epidermis of some twelve genera of fishes. To these cells he gave the general term " schleimzellen." Subsequent research has shown that several varieties were included under this general term.

" Kolben " or club cells

The first of the elements subsequently delimited was the " *Kolben* " *cell* or " Kolbenformige Gebilde " of Max Schultze (1861.2) of the epidermis in Petromyzon. By F. E. Schulze (Add. 1867.1) the " kolben " cells were shown to occur also in Tinca, Leuciscus, Cobitis, Anguilla, Esox, and Silurus, and by Fritsch (G. T. 1886.1) in Malapterurus. These are the *club cells* of authors (" clavate " cells of Wright, R. R. 1884.1, p. 254). Schultze thought the " kolben " cells to be of the nature of nervous end organs and possibly contractile, because of certain appearances in polarized light, resembling those of striated muscle fibre. Although this view has been upheld by Pogojeff (L. 1889.1), nearly all subsequent workers have agreed on their secretory nature. Fœttinger (A. 1876.1) followed their actual extrusion. The careful experimental work of Reid (E. W. 1894.3) on Anguilla, clearly demonstrates that the " club " cells produce the fine granules in the slime and also the threads, which are homologous with and resemble the threads in the slime of Myxine but are of finer texture.

The most comprehensive treatise on the " Kolben " cells, with a table showing the fishes in which they occur or are absent is ★Oxner, M. 1905.1.

" Becherzellen " or goblet cells

The second form of secretory cell is the *goblet* or *Becherzell.* Although known as the

Integument — *Cont'd.*

" Vesicula limpida " of the intestinal epithelium by Henle as early as 1837, the " Becherzellen " were first adequately described by Schulze (F. E. Add. 1867.1). The name " Becherzellen " was first applied by this author in the " Centralbl. f. med. Wiss.," no. 11, 1866. These cells occur in the epidermis of fishes and amphibians, the intestinal epithelium of all vertebrates, and in the " respiratory canal " of lung breathers. The " Becherzellen " receive adequate treatment (bibliographic, historical, etc.) by J. H. List in the Arch. f. mikr. Anat., 1886, vol. 27, pp. 481–588, 6 pls.

According to the researches of Reid (E. W. 1894.3), the goblet cells supply the mucin and after reaching the surface and discharging their load, they are capable of undergoing regeneration.

The club cells, the goblet cells, and the ordinary epidermic cells, are descendants of the palisade cells of the basal layer of the epidermis.

Papers specifically relating to the goblet cells are List, J. H. 1885.1–.3; Helly, K. 1905.1; Oedmannson, – 1863.1; Oeffinger, H. 1867.1.

Epidermis in general

The following papers in general refer to the histological structure of the epidermis including the club and goblet cells and other epidermal elements.

Epidermis of Petromyzon. ★Fœttinger, A. 1876.1; ★Kapelikin, V. 1897.1; Kölliker, R. A. 1860.6; Leuckart, C. G. 1856.1; Loewenthal, N. 1904.1; Marenghi, G. 1903.1; Müller, H. 1864.1,.2; Pogojeff, L. 1889.1; Razzauti, A. 1911.1, 1912.1; Schultze, M. J. 1861.2; ★Schulze, F. E. 1863.1, Add. 1867.1; Studnička, F. K. 1909.1.

Structure of the epidermis in Protopterus. Kölliker, R. A. 1860.1; Paulson, O. M. 1865.1.

Structure of the epidermis in the following Teleosts. — *Salmo fario.* Ebner, V. 1886.1. — *Trachypterus.* Kaschkaroff, D. 1913.1. — *Anguilla.* Lengerken, H. 1913.1; Reid, E. W. 1894.2,.3. — *Teleosts.* Nusbaum, J. & Kulczycki, W. 1906.1,.2. — *Schizothorax and Capœta.* Pavlovskii, E. 1910.1, 1911.2. — *Siluridœ.* Rauther, M. 1907.1.

Thread cells of Myxine

The hagfish or " slime eel," Myxine glutinosa, derived its specific name from its well known habit of exuding enormous quantities of mucus. According to Blomfield (J. E. 1882.1), " two individuals thrown into a bucket of water are capable of gelatinising the whole with their secretion."

This secretion, according to Reid (E. W. 1893.1), is derived from a double row of glands (schleimsäcke of Müller), which are virtually simple involutions of the skin (epidermal inpushings into the dermis), extending along the belly of the animal from head to tail. Each gland has a separate duct to the surface. These structures were first described by Retzius (A. J. 1824.1) but more accurately by Müller (J. 1834.1, v).

The secretion, before its dilution with water, possesses a milky appearance due to the presence of large numbers of cells, whose protoplasm has been converted into a single complexly wound thread which, after exudation, readily unwinds and adds to the viscosity.

These cells, called " Fadenkörper " by Müller, were independently termed " thread cells " by Blomfield. They are apparently specialized forms of the " Kolben " cells, described above, and develop in the epidermal lining of the gland.

Papers relating to the epidermis of Myxine with the thread cells, mucous glands, etc. Blomfield, J. E. 1882.1; Kölliker, R. A. 1860.6; *and* Retzius, M. G. 1905.1.

Chemical examination of the mucous secretions of Myxine shows granules presenting most of the features of a mucin, but which do not yield a body reducing Fehling's solution. ★Reid, E. W. 1893.1, 1894.1.

Bdellostoma also encloses itself in a transparent, gelatinous mass having the consistency of thick egg albumen. Ayers, H. 1894.1.

Cornifications of epidermis

In general the epidermis of fishes is soft and cornifications of it are comparatively rare.

Among such cornifications are the " pearl organs," small tubercles appearing chiefly on the head of various Cyprinidœ, at breeding time. Leydig, F. 1892.2; Reighard, J. 1903.2, 1904.1, 1910.2.

Similar " contact organs " found on the scales or fins of the males of some Pœciliidœ at the breeding season, are not purely epidermal but possess an osseous or dermal core. Newman, H. H. 1907.1, 1909.1.

The " teeth " of the Cyclostomata (lampreys) are cornified epidermal structures. For references, see under Dentition.

Deckplatte. In some embryonic Anamnia, Petromyzon and Amphibia, the outer layer of ectoderm cells may, for a time, be ciliated. The cilia however disappear upon the hardening of the superficial protoplasm of the cells of the stratum corneum to form a so-called cuticula. By Studnička (F. K. 1897.5) this striated cuticular structure is termed " Deckplatte."

In Lepadogaster, the epidermis of the adhesive disk forms a thick cuticular plate. Guitel, F. 1888.1; Studnička, F. K. 1906.1, 1909.1.

THE ARGENTEUM

Underlying the dermis or corium of fishes is a layer of connective tissue, the tela subcutanea.

In many fishes, this layer contains numerous *crystals of guanin* which form a reflecting layer composing the argenteum which produces the *silvery coloration.*

According to Ewald and Krukenberg (1883.1), quoted from Cunningham and MacMunn (1893.1, p. 782), " the guanin is contained in connective tissue cells, in some cases in fine crystalline plates as a lime compound (guaninkalk) (Teleostei, Ganoidei, Cyclostomata), in others in the pure condition, and then it is only dead white, and has no metallic lustre (skin of Selachians)." The presence of guanin likewise frequently gives a silvery appearance to the peritoneum and the air bladder. " The beautiful metallic appearance of the iris in fishes is due to crystals of guanin."

The discovery of the true nature of the guanin is due to Barreswil (Add. 1861.1) who upon making a chemical examination of the " blanc d'ablette " or silvery substance extracted from the skin of the bleak (Alburnus) and used in the manufacture of artificial pearls, decided that this material was identical with the "guanin" isolated by Bodo Unger from guano in 1845. A short time later Voit (C. 1865.1) independently reached the same conclusion.

Early investigations on the nature of the silver substance. Goebel, F. 1836.1; Schnitzlein, A. 1836.1, Add. 1837.1; Wittich, W. H. 1854.1.

Distribution of guanin in the skin of fishes. Bethe, A. 1895.1; ★Cunningham, J. T. & MacMunn, C. 1893.1; ★Ewald, A. & Krukenberg, C. F. 1882.1, 1883.1; Prince, E. E. 1893.2; MacMunn, C. A. Add. 1895.1.

For the use of guanin in making artificial pearls, see this heading below Economic products *under* Fisheries.

For references to the "biological significance of silvery coloration," see Miscellanea *under* Coloration.

LATERAL LINE SYSTEM

For related structures, *see under* Senses and sense organs; Tactile organs; etc.

General treatises. Sède de Lieoux, P. (*Teleosts*) 1884.1; Leydig, F. Add. 1868.1.

Development. Earliest anlage. Mitrofanov, P. I. 1889.1; Wilson, H. V. & Mattocks, J. E. 1897.1; Krause, W. Add. 1906.1. — *Amia.* Beckwith, C. J. 1902.1, 1907.1. — *Torpedo,* Coggi, A. 1902.2. — *Selachii.* Klinkhardt, W. 1905.1. — *Lepidosteus.* Landacre, F. L. & Conger, A. C. 1913.1.

Histology. Solger, B. F. 1880.2. — *Cupula terminalis.* 1887.1. — *Macruridæ.* ★Pfüller, A. **1914.1.**

Innervation (*by branches of the lateralis nerve*). Burne, R. H. 1901.1; Leydig, F. 1850.2, 1851.2; Schulze, F. E. 1861.1.

Physiology, or functions, of the lateral line system. Bonnier, P. 1896.1; Knox, R. 1825.1,.2, 1827.1; Lee, F. S. 1898.1; ★Parker, G. H. 1904.1,.2, 1905.1; Stahr, H. 1897.1. — *Selachii.* Fuchs, S. 1895.1,.2. — *Macruridæ.* ★Pfüller, A. 1914.1. — *Cyprinus.* Richard, J. 1896.1.

Structure of the lateral line system. *Miscellaneous and general.* Agassiz, J. L. 1848.6; Beard, J. 1884.1, 1885.1; Dercum, F. 1880.1; Dunn, M. 1895.1, 1901.1; Marsson, M. 1897.2; Sappey, M. P. 1880.1,.2; Vogt, C. C. 1856.1. — *Fossil fishes.* Collinge, W. E. 1893.2; Woodward, A. S. 1887.7. — *Earliest reference.* Rivinus, A. Q. Pre-Linn. 1687.1.

Larger researches. ★Allis, E. P. 1904.1; ★Heilig, K. 1912.1; ★Hofer, B. 1908.1; Hyrtl, C. J. 1843.1; Macdonnell, R. 1864.1; Pell, M. 1907.1; Schulze, F. E. 1870.1, 1871.1.

Structure of lateral line system in various fishes. — *Ammocœtes.* Leuckart, C. G. 1856.1.

Elasmobranchii. Ewart, J. C. & Mitchell, J. C. 1895.1; Fritsch, G. T. 1888.1; Garman, S. 1888.1; Robin, C. P. 1846.5; Solger, B. F. 1880.1; Todaro, F. 1870.1. — *Mustelus.* Allis, E. P. 1901.1. — *Spinax.* Brohmer, P. 1908.2; Rund, G. Add. 1914.1. — *Torpedo.* Coggi, A. 1891.3; Fritsch, G. T. 1894.2; Müller, H. 1852.1. — *Chimæra.* Cole, F. J. 1896.1,.2; Collinge, W. E. 1895.2; Reese, A. M. 1910.1; Solger, B. F. 1880.1. — *Squaloraja.* Woodward, A. S. 1887.2.

Ganoidei. — *Amia.* Allis, E. P. 1888.1. — *Polypterus.* Allis, E. P. 1900.1; Baur, G. H. 1896.1; Collinge, W. E. 1893.3, 1896.1. — *Polyodon.* Allis, E. P. 1903.3; Nachtrieb, H. F. 1902.1–1912.1. — *Acipenser.* Baer, K. E. 1826.1; Jaquet, M. 1899.2. —*Lepidosteus.* Collinge, W. E. 1893.1. —*Ganoidei.* Collinge, W. E. 1894.1, 1895.5; Kingsbury, B. F. 1896.1.

Teleostei. Dantan, L. 1906.1; Leydig, F. 1850.1; Solger, B. F. 1878.2, 1880.1, 1882.2, Add. 1877.2. — *Murænidæ.* Allis, E. P. 1903.1. — *Cottus.* Bodenstein, E. 1883.1. — *Siluridæ, chiefly Ameiurus.* Bunker, F. S. 1897.1; Fritsch, G. T. (*Malopterurus*) 1886.1; Herrick, C. J. 1901.1; Pollard, H. B. 1892.1; Wright, R. R. 1884.1. —*Batrachus.* Clapp, C. M. 1899.1; Jordan, D. S. 1900.2. — *Icosteus.* Cohn, L. 1906.1. — *Gadus.* Cole, F. J. 1898.1. — *Physostomi.* Collinge, W. E. 1895.4. — *Mugil.* Fée, F. 1869.1. — *Lepadogaster.* Guitel, F. 1887.2. — *Cyclopterus.* 1889.1. —*Lophius.* 1890.1, 1890.2, 1891.1. —*Lota.* Hyrtl, C. J. 1866.1. — *Clupea.* Ryder, J. A. 1890.3. — *Percoids.* Steindachner, F. 1862.1 (ii).

SENSORY ORGANS

Which are closely associated with the lateral line

Ampullæ of Lorenzini, *mucous canals or subcutaneous pit-organs found on lateral and dorsal surfaces of the heads of Elasmobranchs.*

Morphology, development, etc. Boll, F. 1868.1; ★Coggi, A. 1891.2, 1902.1,.2, 1905.1; Brohmer, P. 1908.2; Forssel, G. 1894.1; Johnston, J. B. 1902.5; ★Minckert, W. 1901.1; Peabody, J. E. 1897.1; Retzius, M. G. 1898.3; Rund, G. Add. 1914.1.

As organs for pressure perception. Metcalf, H. E. 1915.1.

Ampullary canals in Chimæra. Cole, F. J. 1896.2; Collinge, W. E. 1895.2.

Ampullæ of Savi (*Savi's vesicle*), *of the ventral surface of the head of Torpedo.*

Anatomy. ★Boll, F. 1875.1; Coggi, A. 1891.3; Fritsch, G. T. 1894.2; Garman, S. 1892.4; Kölliker, R. A. 1857.4.

LIVER (*INCLUDING GALL BLADDER*)

For associated structures, *see* Intestine *and* Stomach *under* Alimentary Tract, *also* Pancreas *and* Spleen.

For the occurrence of glycogen in the liver, and for the role of the fat content of the liver of sharks, *see under* Chemistry.

For urea formation in the liver, *see* Excretion *under* Physiology.

Anatomy and morphology, general accounts. Guillot, N. 1846.1, 1848.1; Jones, H. 1854.1; Mierendorff, F. W. 1817.1; Rathke, M. H. 1826.1,.4, 1837.2; Weber, E. H. 1827.8; Schmid, F. C. Add. 1882.1; Shore, T. W. & Jones, H. L. Add. 1889.1.

Liver — *Cont'd.*

— *Glandular structure.* Retzius, M. G. 1892.6.

Anatomy of liver in various fishes. — *Ammocœtes and Petromyzon.* Dervieux, L. 1898.1; Kuliabko, A. A. 1898.1. — *Ameiurus.* Macallum, A. B. 1884.1. — *Callionymus.* Pilliet, A. H. 1889.1. — *Selachii.* Pilliet, A. H. 1890.2. — *Teleosts.* Segerstråle, E. 1910.1. — *Clarias.* Weber, M. C. 1891.1.

Development, general papers. ★Choronshitsky, B. 1900.1; Piper, H. 1902.1,.2,.3.

Development in various fishes and groups of fishes. — *Ammocœtes.* Brachet, A. 1897.1. — *Elasmobranchii.* Brachet, A. 1896.1; Hammar, J. A. 1893.1, 1897.1; Scammon, R. E. 1913.1. — *Dipnoi.* Broman, I. 1905.1; Neumayer, L. (*Ceratodus*) 1904.1,.3. — *Amphioxus.* Hammar, J. A. 1898.1. — *Acipenser.* Nicolas, A. 1904.1. — *Trout.* Stöhr, P. A. 1893.1; Stricker, F. 1899.1.

Histology. Holm, J. F. 1897.1; ★Oppel, A. Add. **1900.1**. — *Acipenser and Ceratodus.* Bluntschli, H. 1903.1, 1904.1. — *Selachii.* Scammon, R. E. 1915.1. — *Amphioxus.* Zarnik, B. 1905.1.

Gall bladder. — *Anatomy.* Cabibbe, G. 1903.1. — *Development.* ★Choronshitsky, B. 1900.1. — *Development, Elasmobranchs,* Scammon, R. E. 1913.1. — *Biliary calculi in squeteague.* Tower, R. W. 1902.1.

Bile ducts. — *Ductus cysticus, structure.* Hyrtl, C. J. 1868.1. — *Liver ducts, development.* Scammon, R. E. 1913.1.

For the chemical composition of bile, see under Chemistry.

LOCOMOTION

For the organs of locomotion, *see* Fins.

For the flight of fishes, *see* Flying-fishes.

For the hydrostatic functions of the swimbladder, *see under* Air bladder.

For the maintenance of equilibrium, *see under* Hearing and the static sense.

For a comprehensive review in German of all technical researches on locomotion, see ★Du Bois-Reymond, R. Add. **1914.1**.

For a popular treatise in English on all kinds of locomotion in animals including fishes, see ★Pettigrew, J. B. Add. 1883.1.

Miscellaneous items, not readily classifiable. — *Relation of number of myotomes to bodily rigidity.* Magnan, A. & La Riboisière, J. 1912.1. — *Methods of fixation against strong currents by means of spines.* Thilo, O. 1900.1, 1903.1. — *Influence of high pressures on muscular contraction.* Regnard, P. 1887.1.— *Demonstration of steering mechanism of fishes.* Völker, H. 1911.1.

Experimental researches

Effects on locomotion, of the extirpation or section of various parts of the central nervous system. Bethe, A. 1899.1; Polimanti, O. 1911.3,.5, 1913.1; Rynberk, G. A. 1905.5, 1906.4, Add. 1904.1; Corblin, H. Add. 1888.1.

Experiments in removing different fins; caudal considered chief locomotor organ of sharks. Mayer, P. 1886.1. — *Similar exps. with teleosts.* Monoyer, F. 1866.1,.2. — *Similar experiments with the cyprinodont, Goodea.* Dugès, A. 1905.1,.2. — *Comment on Dugès.* Osburn, R. C. 1906.1.

Swimming in fishes

General accounts. Text in — *Dutch.* Brugmans, S. J. 1812.1; Winkler, T. C. 1860.3. — *French.* Amans, P. C. 1887.1, 1888.1; Chevrel, R. 1913.1; Giraud-Teulon, M. A. 1856.1, Add. 1858.1. — *German.* Bickel, A. 1896.1; Meier, H. 1860.1; Thilo, O. 1901.1. — *Italian.* Ducceschi, V. Add. 1903.1.

Miscellaneous and relatively unimportant papers. Text in English. Bennett, E. F. 1899.1; Buckland, W. 1844.1; ★Kent, W. S. 1873.1, 1874.3; Nichols, J. T. 1912.7; Wilder, B. G. 1870.1.

Miscellaneous papers in German. Ahlers, C. 1900.1; Brehm, A. E. 1871.1; Kathariner, L. 1899.1; Schlesinger, G. 1911.2; Anon. 175, 609, 610.

Miscellaneous papers with text in — *French.* Corblin, H. 1887.1, Add. 1888.1; Gouriet, E. 1864.1. — *Italian.* Dei, A. 1896.1. — *Dutch.* Harting, P. 1873.3. — *Norwegian.* Kent, W. S. 1874.2. — *Finnish.* Regnard, P. 1893.3. — *Polish.* Staff, F. 1911.1.

TYPES OF SWIMMING

Borelli's theory; that in swimming, the tail vibrates on either side of a given line which corresponds to the axis of the fish when the body is straight. This is the axis of motion; the tail acts as a rudder. Borelli, G. A. Pre-Linn. 1680.1. — *Remarks on Borelli.* Winslow, J. B. Pre-Linn. 1738.1.

Undulating, wriggling, or eel-like locomotion and related types. Schlesinger, G. 1911.1,.3; ★Strasser, H. **1882.1**, 1883.1.

Progression of sharks by undulation or the swaying from side to side of the unsymmetrical caudal fin and the whole posterior part of the body. Ahlborn, C. G. 1895.2; Polimanti, O. 1911.3.

Screw propeller action of single median dorsal fin rapidly vibrating from end to end in pipefishes, Syngnathidæ. — *Hippocampus.* Anthony, R. & Chevroton, L. 1913.1; Ishihava, M. 1905.1. — *Syngnathus.* Weinland, D. F. 1856.2.

Progression by vibration of the elongated median anal fin of Notopteridæ. Schlesinger, G. 1910.3.

Swimming with tail and walking on bottom with dactyliform rays of the pectorals, Trigla. Chabry, L. 1883.1; Deslongchamps, J. A. 1843.1; Polimanti, O. 1911.3. — *Prionotus,* Allen, H. 1886.1.

Observations on the vertical swimming position of Amphisile strigata. Willey, A. Add. 1902.1.

Unusual types of locomotion

Climbing habits and overland progression of the "climbing-perch," Anabas scandens. Daldorff, D. C. 1797.1; Mitchell, J.

1864.1; Neill, B. A. 1864.1; Zur Mühlen, M. 1911.22; Layard, E. L. Add. 1853.1.

Climbing of the Andean catfish, Arges marmoratus. Johnson, R. D. 1912.1, Add. 1913.1.

Ichthyopatolites or petrified track-wings of ambulatory fishes. Buckland, W. 1843.1.

Leaping habits of marine fishes, ascent of water-falls, etc. Clapham, T. 1879.2; Dumesnil, A. 1906.1; Holder, C. F. 1903.3; Smith, Everett 1879.1.

Lampreys ascending water-falls. Smith, H. M. 1900.3, 1902.6.

Overland progression or terrestrial locomotion of. — Doras and Callichthys. Allen, G. 1885.1; Hancock, J. 1828.1. — *Gobiesox, found 40 feet from water.* Pickering, C. 1862.1. — *Xenomystus.* Schlesinger, G. 1912.2. — *Clarias.* Vaillant, L. L. 1895.3, 1896.3. — *Unnamed fishes.* Anon. 619; Gostling, D. Add. 1894.1.

Overland migrations of the eel, Anguilla. Danner, H. 1880.1; Lengerke, – 1876.1; Lindes, L. 1880.12; Schreitmüller, W. 1914.11; Anon. 3, 254.

Terrestrial progression of Periophthalmus by hopping in mud. Allen, G. 1885.1; ★Johnstone, J. 1903.2; Martens, E. 1881.1; Pickering, C. 1862.1.

Terrestrial locomotion of Gasterosteus. Gergens, – 1862.1.

LUMINOSITY AND PHOSPHORESCENCE (*OF FISHES*)

Comprising the production of light by means of specialized photogenic organs, *which occur chiefly in the deep-sea fishes.*

Miscellaneous observations, notes, popular accounts, etc., on the luminosity or phosphorescence of fishes, luminous fishes, phosphorescent organs, etc.

Text in English. Bell, F. J. 1881.1; Hall, J. J. 1872.1; Franklin, C. L. 1900.1; Kent, W. S. 1873.4; ★McIntosh, W. C. 1885.3, 1906.3; Nicols, A. 1872.1; Nutting, C. C. 1899.2; Shufeldt, R. W. 1894.1, 1907.1; Weber, M. C. 1901.1.

Text in French. Deslongchamps, J. A. 1838.1; Gadeau de Kerville, H. 1890.1; Khvorostansky, C. 1892.1; Mulder, E. 1861.1.

Text in German. Dittrich, R. 1888.1; Doflein, F. J. 1906.3; Frisch, K. 1909.1; Gadeau de Kerville, H. 1893.1; Haupt, H. 1903.1; Marenzeller, E. 1889.1; Pütter, A. 1905.1; Radziszewski, B. 1880.1; Schenkling-Prévôt, – 1902.1; Schneider, G. 1904.9; Stenta, M. 1905.1; Thilo, O. 1910.2; Zugmayer, E. 1910.2; Anon. 338.

Text in — Italian. Giglioli, E. H. 1870.1. — *Dutch.* Harting, P. 1866.5; Mulder, E. 1859.1; Anon. 602. — *Swedish.* Lönnberg, A. J. 1904.1. — *Latin.* La Faille, J. M. Add. 1821.1.

LIGHT PRODUCTION

Physiology of luminescence

For a scholarly treatise on light production in all groups of animals including fishes, with a full bibliography, see ★Mangold, E. Add. **1910.1**.

An excellent recent physico-chemical treatise, including all groups of light-producing organisms, is ★" The nature of animal light " *by* E. Newton Harvey. Philadelphia and London (Monographs on experimental biology), 1920, 182 pp., 35 figs.

Physical base of animal phosphorescence. Watase, S. 1895.1.

Three-day old specimens of Ephippus (surface fishes without luminous organs) were very decidedly phosphorescent at night when sudden impulses were imparted to the water. Ryder, J. A. 1880.1.

Observations on the emission of light by living fishes. Our belief in the existence of luminous organs in fishes is based on their comparative structure and the following few actual observations on living fishes.

For a résumé of all such observations, including a few additional to those given below, see ★Brauer, A. 1908.2 (pp. 127–133). *These are repeated in* Mangold, E. 1907.1 *and* 1910.1.

First notice of light emission in fishes. Astronesthes fieldii, observed during a voyage to Brazil, "sent forth two strong and vivid greenish lights, which intermitted momentarily, and ceased altogether when the fish died." Reinhardt, J. T. 1853.1, 1854.1. — *Astronesthes observed also by* Vanhöffen, E. 1901.1.

Luminosity of post-orbital organ of Melanostomias melanops seen during Valdivia Expedition. Brauer, A. 1908.2 (p. 87).

Porichthys, placed in an aquarium made alkaline with ammonia water, exhibited a brilliant white light for about twenty minutes. Greene, C. W. 1899.1.

A nearly dead specimen of Scopelus boops dredged off the Cape of Good Hope, "displayed a faint though an undoubted luminosity . . . in the pectoral region." Guppy, H. B. 1882.1.

Maurolicus pennantii observed in the Naples aquarium. Mangold, E. 1907.1.

Among coral reefs of Malay peninsula, Steche observed a continuous glow in Photoblepharon and intermittent flashes in Anomalops. Steche, O. 1907.1, 1909.1.

Sternoptyx, brought up in the trawl at night in the North Pacific, glowed like a luminous star. Willemoes-Suhm, R. 1875.1.

Isistius brasiliensis, a spinacid shark, captured in Australian seas, was placed in an aquarium and remained aglow for about three hours. Bennett, F. D. 1840.1.

Spinax niger in a darkened room at the Naples aquarium, glowed "with a feebly shining greenish lustre." Note by Th. Beer in Johann, L. 1899.1. — *"Spectral colors" of Spinax at Naples, visible even in daylight.* Burckhardt, C. R. 1900.2.

PHOSPHORESCENT ORGANS

Photophores or radiating organs

The nature of these organs was originally disputed and they were termed

Luminosity — *Cont'd.*

" accessory eyes " by Usov, and " eyelike pigment spots " by Leydig. By these authors and others they have been called " accessorische Augen," " augenähnliche Flecken," " Nebenaugen," " Pseudo-augen," oculiform organs, pearly organs, etc.

Luminous organs are recorded from fishes belonging to 69 genera and 239 species by ★Brauer, A. **1908.2.**

General treatises

Structure of the phosphorescent organs.

Text in English. ★Lendenfeld, R. **1887.2,** 1905.1.

Text in German. ★Brauer, A. 1904.4–**1908.2;** Lendenfeld, R. 1887.1, 1891.1; Leydig, F. 1881.1; Solger, B. F. 1881.1; Trojan, E. 1906.2.

Text in Italian. Chiarini, P. 1900.1; Chiarini, P. & Gatti, M. 1899.1; Gatti, M. A. 1899.1, 1904.1.

Structure in various fishes

SELACHII

All Selachians which possess luminous bodies are pelagic and belong to the family Spinacidæ (including Læmargus). ★Burckhardt, C. R. 1900.2; Johann, L. 1899.1; — *Selachii generally.* Leydig, F. 1909.1; Ohshima, H. 1910.1, 1911.1.

TELEOSTEI

Various general papers. Brauer, A. 1904.4, 1905.1; Chun, C. 1893.1; Guerne, J. 1880.1; ★Usov, M. M. 1879.1, 1880.1.

Structure of the phosphorescent organs in — *Lamprotoxus.* Boulenger, C. L. 1913.1. — *Argyropelecus.* Brandes, G. 1899.1; ★Handrick, K. 1901.1. — *Chauliodus.* Brandes, G. 1899.1; Lereboullet, D. A. 1864.4; Leydig, F. 1879.2; Leuckart, R. 1865.1, 1866.1. — *Anomalops.* Dahlgren, U. 1908.1. — *Anomalops and Photoblepharon.* ★Steche, O. 1907.1, 1909.1; Weber, M. 1901.2, 1913.1. — *Porichthys.* Eigenmann, C. H. & Eigenmann, R. S. 1889.7; ★Greene, C. W. 1899.1. — *Scopelus.* Emery, C. 1884.1, 1888.1, 1890.1. — *Maurolicus.* Groot, G. J. 1908.1. — *Ipnops.* Moseley, H. N. 1887.1. — *Myctophidæ and Sternoptychidæ.* Ohshima, H. 1910.1, 1911.1. — *Gonostoma (young).* Sanzo, L. 1912.1. — *Cyclothone.* ★Trojan, E. 1915.1. — *Heterophthalmus.* Vorderman, A. G. 1900.1.

PHOSPHORESCENCE OF DEAD FISH

This phosphorescence, appearing in both marine and fresh-water fish, meat, vegetable matter, etc., is caused by photogenic bacteria, especially *Bacterium phosphoreum.* (Cohn.)

For a full discussion of the subject, see ★Mangold, E. Add. 1910.1. *See also* Barnard, J. E. *in* Jenner Instit. Prev. Med., 2nd ser. Aug. 1899, pp. 81–112.

Various papers, chiefly speculations on the causes of the phosphorescence. (True nature not recognized before Pflüger's suggestion.) Matteucci, C. 1848.1; ★Pflüger, E. F. 1875.2; Phipson, T. L. 1860.1; Hulme, N. Add. 1800.1; Martin, A. R. Add. 1761.1,.2, 1765.1; Beal, J. Pre-Linn. 1666.1.

Recording luminous fat in Trachypterus, doubtless a bacterial luminescence. Panceri, P. 1871.1, 1872.1. — *Review of this.* Baird, S. F. 1871.33.

Early experiments. Boyle noticed decrease of phosphorescence when a vacuum was created. Boyle, R. Pre-Linn. 1667.1, 1670.2.

MEDICAL PROPERTIES (*ALLEGED, OF FISHES*).

For a valuable recent work in English, with a discussion of the use of fishes by the Greeks and Romans as prophylactic and curative agents in rabies, toothache, pregnancy, etc., see ★Wm. Radcliffe. " Fishing from the earliest times." London. 1921. 478 p. ills.

Purgative effects of oil of Ruvettus, "purge-fish" of South Seas. Krämer, A. 1901.1; Waite, E. R. 1899.1.

Use of electrical fishes as shock machines. — *Alleged use of electrical eel in Surinam.* Lott, F. 1762.1; Wilson, G. 1857.1, 1860.1. — *Torpedo used.* Frenzel, J. S. Add. 1777.1; Kaempfer, E. Pre-Linn. 1694.1.

Use of fishes in the medical practice of the 16th-18th centuries. Badham, C. D. 1854.1; Moquin-Tandon, C. 1860.1; Surbeck, G. 1901.2.

The following references will be found in the Pre-Linn. *section.*

Text respectively in French, Dutch, and Italian. Arnault, de N. & Salerne, F. 1756.1; Bontius, J. 1642.1; Matthioli, P. A. 1548.1.

Text in English. Keogh, J. 1739.1; Kiranus, 1685.1; Lovell, R. 1661.1; Mandeville, B. 1739.1; Schroeder, J. 1659.1.

Text in German. Bapst, M. 1590.1; Bock, H. 1539.1; Durante, C. 1585.1, 1593.1; Mercklein, G. A. 1696.1.

Text in Latin. Bossche, G. 1639.1; Cirino, A. 1653.1; Dale, S. 1693.1; ★Dioscorides, P. 1478.1; ★Galenus, C. 1490.1; Helmont, J. 1707.1; Koenig, E. 1682.1; Nonnius, L. 1627.1; ★Oribasius, 1555.1; Sidren, J. 1750.1; ★Xenocrates, 1559.1; Anon. 753.

Supposed medical virtues of — *Tench.* Camerarius, J. R. 1624.1, 1683.1. — *Mullet.* Marcellus Sidetes, 1705.1. — *Herring.* Neucrantz, P. 1654.1. — *Liver of eel.* Panarolli, D. 1654.1.

METAMERISM

For organs definitely metameric in structure, *see* Head; Myomeres *under* Myology; Medullary tube *under* Embryology; Skeleton; Skull; Vertebral column; *and* Visceral Skeleton.

For the extensive literature on the metamerism of the head, *see under* Head.

In general, note papers of A. Dohrn whose researches (1876–1906) treat all aspects of this problem.

General papers on the metameric structure of the animal body. Ahlborn, C. G. 1884.2; Gaskell, W. H. 1898.1 (xi.); Hatschek, B. 1892.1,.2; Schultze, O. 1896.1.

Metamerism of the embryonic central nervous system. ★Barbieri, C. 1909.1; ★Hawkes, O. A. 1905.2; Locy, W. A. 1894.1; McClure, C. F. 1897.1; Neal, H. V. (*Squalus*) 1896.1; Waters, B. H. 1891.1, 1892.1; Henneguy, L. F. Add. 1888.1.

Metamerism of the cranial nerves. Beard, J. 1885.2; Herrick, C. J. 1899.2; Ihering, H. 1878.1; Mitrofanov, P. I. 1892.2; ★Nicholls, G. E. 1915.1; Shore, T. W. 1889.1; Marshall, A. M. Add. 1882.1.

Metameric motor nerve plexuses. Braus, H. 1909.1; Goodrich, E. S. 1910.1.

Metamerism in the sympathetic nervous system. Rynberk, G. A. 1906.2. —*Segmental innervation of skin by sympathetic nervous system.* Rynberk, G. A. 1905.1, 1907.1.

Metameric structure of mesoderm and entoderm. —*Petromyzon.* Hatta, S. 1901.2. —*Head mesoderm, Amphioxus.* Hatschek, B. 1906.1–1910.1. —*Head mesoderm, Cyclostomes.* Neal, H. V. 1915.3. —*Entoderm and circulatory system of the trunk.* Houssay, F. 1891.1.

Metameric structure of the skin. —*Selachii.* Grosser, O. 1905.1; Rynberk, G. A. 1905.3, 1908.1.

Metamerism of the longitudinal muscles. Harrison, R. G. Add. 1894.1.

MIGRATIONS OF FISHES

Some of the anadromous fishes, *i. e.* those which spend the greater part of their life in the sea, such as the salmon, run up for several thousand miles, to the headwaters of rivers, in search of a suitable place to spawn. Others which grow to maturity in the fresh-water streams or lakes (catadromous fishes), like the eel, perform a migration of no lesser distance from the rivers of Europe and North America to depths off the West Indies, travelling also for the purpose of reproduction. Other marine fishes annually move northward and southward in pursuit of their food. Thus the subject of migrations is intimately related to that of their breeding and feeding habits and their life-histories, and cannot, in the case of Anguilla, Pleuronectidæ, and Salmonidæ, be readily treated separately. References to the migration of these fishes will therefore be found under the sections, Anguilla, Pleuronectidæ, and Salmonidæ, respectively.

The most recent and comprehensive work (in English) on "Migrations of Fishes" is ★Meek, A. **1916.1.**

The various workers of the regional Fisheries Bureaus of the International Commission for the Investigation of the Sea have made the most detailed records and observations of the migrations of the principal North-Atlantic food fishes. Their papers have largely been published in the publications of the Commission, especially Rapports et Procés-Verbaux, *and also* Publications de Circonstance *of the* Conseil Permanent International pour l'Exploration de la Mer, Copenhagen; *and* Meddelelser fra Kommissionen for Havundersögelser, Serie Fiskeri, Copenhagen; *and* Wissenschaftliche Meeresuntersuchungen der deutschen Meere in Kiel und der Biologischen Anstalt auf Helgoland.

Other older, general treatises are: Berthelot, S. 1875.1; ★Goode, G. B. 1878.4; Homeyer, E. F. 1881.1; Roule, L. 1914.2; Serres, P. M. 1842.1; Woltereck, R. 1908.1.

Influences of currents, weather conditions, vulcanism, etc., on migrations. Armistead, J. J. 1894.1, Add. 1888.1; Krebs, W. 1911.2, 1912.1; Masterman, A. T. 1897.3; Nordgaard, O. 1910.1; Willis-Bund, J. W. 1887.1.

To define migrations which are intimately associated with currents, the terms contranatant and denatant are proposed by Meek, A. 1915.2.

Migrations in various localities

Notes on the appearance or migration of fishes in —*Sweden.* Aurivillius, C. W. 1899.1. —*Massachusetts.* Blake, J. H. 1870.1; Slade, E. 1883.1. —*Volga delta.* Deržavin, A. 1913.1; Tereschenko, K. K. 1912.1. —*Lake Geneva.* Chatelanat, H. 1874.1. —*Baltic Sea.* Franz, V. 1908.1; Strodtmann, S. 1906.1, 1911.1. —*Norway.* Helland, A. T. 1908.1. —*North Sea.* Henking, H. 1905.1. —*Venezuela.* Ernst, G. A. Add. 1886.1.

Records of the annual appearance of various tropical fishes, including sharks and rays, on the North Carolina coast. Coles, R. J. 1913.1.

Evidence of migrations in Belgium during the Palæozoic era. Lohest, M. 1888.2.

Migrations of various fishes

Additional data on migrations will probably also be found in the references to Natural History *under the fishes referred to below.*

Acipenser. Antipa, G. 1906.1; Nazarov, J. 1901.1.

Caspiomyzon (from Caspian Sea into the Volga). Pravdin, I. F. 1913.1.

Petromyzon. Anon. 621.

Teleostean fishes

Herring (Clupea harengus). Baird, S. F. 1878.5; Baženov, A. 1906.2; ★Broch, H. 1908.1,.2; ★Cligny, A. 1912.9, Add. 1907.1, 1914.1; Gilpin, J. 1786.1; Golynetz, W. 1907.1; Hinkelmann, A. 1902.1; Krebs, W. 1911.1; Kuznetzov, I. D. 1894.1; Lindahl, J. 1878.1; Mitchell, J. M. 1861.1; Morrison, W. D. 1829.1; Noël de la Morinière, S. 1795.1; Pearcey, F. G. 1884.1; Schneider, J. G. 1788.2; Sim, G. 1883.2; Watt, W. 1883.3; Ziegler, A. 1857.1; Anon. 366; Rappolt, C. H. Pre-Linn. 1739.1.

Various other Clupeidæ. —*Alewives.* Bean, T. H. 1881.4. —*Pilchard.* Bolitho, T. S. 1851.2; Cornish, T. 1883.3; Couch, R. Q. 1851.4. —*Anchovy.* Cunningham, J. T. 1893.7. —*Sprat.* Eichelbaum, E. 1911.1. —*Menhaden.* Grant, I. H. 1883.1. —*Clupeidæ (herring excepted).* Hoek, P. P. 1912.1. —*Shad.* Smith, C. J. 1880.2.

Migrations — *Cont'd.*

Migrations of the mackerel. ★Allen, E. J. 1897.3, 1909.1; B., G. A. 1878.1; Badenoch, L. N. 1903.1; Cligny, A. 1905.2; Collins, J. W. 1883.5, 1884.2; Dunn, M. 1893.1; ★Garstang, W. 1897.3, 1898.1; Martin, S. J. 1883.2,.3,.4; Morrison, W. D. 1829.1; Tanner, Z. L. 1883.1.

Migrations of the tunny (Thynnus). Bounhiol, J. P. 1911.1,.2,.3; Niewenglowski, G. H. 1913.1; ★Pavesi, P. 1887.1; Roule, L. 1913.6; Strabo, – Pre-Linn. 1472.1.

Migrations of other Teleostean fishes. — Bluefish (Pomatomus). Baird, S. F. 1871.39. — *Cottus.* Forsberg, A. 1898.1. — *Crappie (Pomoxys).* C., S. W. 1878.1. — *Galaxias, migration from sea to fresh water.* McCulloch, A. R. 1915.1. — *Mugil.* Gummerus, A. 1898.1; Roule, L. 1915.1,.3. — *Trigla.* Fulton, T. W. 1899.1; Meek, A. 1915.4. — *Whitefish.* C. 1878.1; Tomlin, W. D. 1888.1.

Marking experiments

For the determination of the rate of growth, the rate of travel during migrations, and other facts concerning their life histories, various experiments or attempts in marking fishes have been made, chiefly by the use of metal disks, by the removal of parts of fins, or by other recognizable mutilations. Some references to these attempts will be found *under* Anguilla, Pleuronectidæ, *and* Salmonidæ.

Other papers relating to the marking of North Sea fishes are Fulton, T. W. 1904.2; Garstang, W. 1905.5, 1912.1; Herdman, W. A., Scott, A. & Johnstone, J. 1905.1–1909.1.

Marking experiments on the cod (Gadus) in — the North Sea. Borley, J. O. 1909.1. — *in Icelandic waters.* Sæmundsson, B. 1913.1; Schmidt, E. J. 1907.1. — *Tagging adult cod at Woods Hole, Mass.* Smith, H. M. 1902.10. — *German experiments.* Redeke, H. C. 1909.1; Weigold, H. 1913.1.

Miscellaneous papers on migrations

Text in English. Aflalo, F. G. 1902.5; Agassiz, J. L. 1858.2; Anderson, J. 1800.1; Epton, J. 1883.1; Gould, N. E. 1885.1; Klippart, J. H. 1876.1; Lyman, T. 1868.2; Lyman, T. & Field, A. R. 1867.1; McDonald, M. 1885.2; Milner, J. W. 1880.1,.2; Norris, T. 1873.1; Thomson, J. H. 1878.2; Kirby, W. Add. 1835.1.

Text in French. Baude, J. J. 1861.1; Belloc, E. 1903.1; Duméril, A. H. 1866.3; Nillson, S. 1860.2; Rafinesque-Schmaltz, C. 1814.3; Watterbled, – Add. 1882.1.

Text in German. Buxbaum, L. 1892.1; Ehrenbaum, E. 1911.7; Franz, V. 1910.7, .10, 1911.2; Heincke, F. 1880.2; Jaeger, – 1911.1; La Valette St. George, A. 1901.1; Leonhardt, E. E. 1903.6; Müllenhoff, K. 1885.1; Römer, F. 1909.1; Schiemenz, P. 1904.2.

Text in Norwegian. Huitsfeldt-Kaas, H. 1909.1.

Text in Russian. Gracianov, V. I. 1908.1.

MORTALITY

For diseases causing epidemics, *see under* Pathology.

For destruction through "Pollution" by industrial wastes, *see* Depletion *under* Fisheries.

Miscellaneous papers. Carbonnier, P. 1866.1; Hofmann, E. 1903.1; Pelletan, J. 1867.1; Petersen, C. G. 1886.1; Schmidt, F. 1874.2; Ysabeau, A. 1867.1; Anon. 640.

Winter killing in lakes; causes, etc., considered chiefly due to lack of oxygen. Kochs, W. 1891.1; Lühder, W. 1871.1; Nordqvist, O. F. 1897.7; Sandman, J. A. 1892.5.

PHYSICAL CAUSES OF MORTALITY

For instances of death caused by excessive cold and heat, *see under* Temperature, effects.

Earthquakes destroying fishes. — *At Catania, Sicily, in 1908.* Condorelli-Fr., M. 1909.1. — *Deep-sea fishes killed in the western Riviera, Italy.* Giglioli, E. H. 1887.1; Bellotti, C. Add. 1887.1. — *Fishes destroyed by eruption of Mt. Vesuvius.* Lo Bianco, S. 1907.1.

Hurricanes and monsoons, causing destruction. — *Monsoon off coast of India.* Denison, W. 1862.1. — *Destruction through hurricane of Jan., 1839, in Ireland.* Thompson, W. 1838.2. — *Hurricane at Scilly Is.* Anon. 236.

Lightning and thunder. *Thunder storms causing mortality.* Knauthe, K. 1901.1,.2; Nicklès, F. J. 1868.1; Sendler, A. 1902.1. — *Fishes killed by lightning in Brenet See, Switzerland.* Zur Mühlen, M. 1911.3. — *Disappearance of fishes during electrical storms.* Coles, R. J. Add. 1914.1.

MORTALITY IN VARIOUS LOCALITIES

Records of occurrence of extensive mortality at — Manila, 1767. Gentil, W. 1781.1. — *South Africa.* Gilchrist, J. D. 1905.1. — *Malabar coast.* Jouan, H. 1875.1. — *On coast of Sumatra.* Marsden, W. Add. 1781.1. — *National Park Dam, New South Wales, 1888.* Ogilby, J. D. Add. 1888.5.

America. *Canada. — Bay of Fundy.* Adams, A. L. 1868.1. — *Near Cape Hatteras (codfish).* Leslie, C. C. 1883.1.

South America. — Callao, Peru. Alleged cause; Hydrogen-sulphide. Burtt, J. L. 1852.1; Hutchinson, T. J. Add. 1873.1. — *In Rio de la Plata.* Lahille, F. Add. 1912.1.

United States. — Blue gills (Lepomis pallidus) in Indiana. Large, T. 1897.1. — *Salmon in McCloud R., Cal., 1881.* Stone, L. 1882.1. — *Minnesota.* Washburn, F. L. 1886.1. — *Rhode Island.* Knowles, H. M. 1887.1. — *Wisconsin, Racine R.* Hoy, P. R. 1872.1. — *Epidemic in Lake Mendota, Wis., 1884.* Dunning, P. 1884.1; Forbes, S. A. 1890.1.

Europe. *British Isles. — Haddock on coasts of Northumberland, Durham and Yorkshire.* Abbs, C. 1792.1. — *Between*

New Brunswick and England. Symonds, W. S. 1855.1. — *Mass mortality in Colne R. at Watford.* Brett, A. T. Add. 1890.1.

France. — *Marseilles: due to Hydrogen-sulphide.* Blanchet, R. 1844.1, 1845.1. — *In French rivers.* Charvet, P. A. 1869.1. — *Salmo salar in Loire R.* Rollinat, R. 1913.1. — *Pond fishes, 1788.* Varenne de Fenille, - 1789.1.

Germany. Schoenichen, W. 1904.1. — *Wrangelsburg (Prussia), 1863.* Clunie, J. & Boll, E. 1863.1. — *In Spree R.* Potters, K. 1896.1. — *In Neckar and Rhine rivers.* Zimmermann, E. R. 1907.1.

Italy. Lake Comacchio: for epidemic destructive to eel (Pestis rubra anguillarum), see Diseases caused by Bacteria *under* Pathology.

Russia. — *Goktscha lake.* Lebedintsev, A. A. 1905.4. — *Reval.* Murzajev, B. B. 1909.1. — *Malmby creek, Finland.* Nordqvist, O. F. 1902.2.

Switzerland. — *Esox in Lake Geneva, 1887.* Blanc, H. 1888.1; Fatio, V. 1887.1, Add. 1887.1. — *Alosa finta (Agoni) in Lake Lugano.* Heuscher, J. 1905.1; Mazzarelli, G. F. 1904.2, 1905.3, 1909.1; Studer, T. 1902.1.

Mortality in Gulf of Mexico *and along Florida coast, and theories concerning causes, probably seismological or volcanic — so-called "poisoned water."* Glennan, A. H. 1887.1; Moore, M. A. 1881.1; Nuñez Ortega, A. 1877.1, 2, 1879.1; Pierce, H. D. 1883.1, 1884.1; Stearns, S. 1878.2; Walker, S. T. 1883.1; Webb, J. G. 1886.1.

See also Proc. U. S. Nat. Mus., *vol.* 1, 1878, *pp.* 244–246, 363–364; *vol.* 4, 1881, *pp.* 74–80, 121–127, 205; *vol.* 6, 1883, *pp.* 105–106.

For a recent review, see ★Taylor, H. F. *in* Rept. U. S. Bureau Fisheries, 1917, Append.

MUSEUMS OF THE WORLD

No attempt has been made here to notice the literature relating to researches on material in the various museums. The publications of the museums concerned ordinarily comprise the bulk of such contributions.

The following list includes guide-books, and lists or catalogues of particular or special collections.

For plans for exhibition of fishes, methods of installation, taxidermy, etc., *see under* Collection, preservation and exhibition.

ASIATIC MUSEUMS

Indian Museum at Calcutta: guide. Alcock, A. W. 1899.2.

Museum Bombay Nat. Hist. Soc.; catalogue. Bassett-Smith, P. W. 1897.1.

Government Central Museum, Madras; cat. Bidie, W. 1874.1.

Colombo Museum, Ceylon; notes. Haly, A. 1886.1. — *Guide.* Willey, A. 1906.1.

Japan: Imperial Museum, Tokyo; catalogue. Ishikawa, C. & Matsuura, K. 1897.1.

Siberia: Government Museum at Tobolsk. Pignatti, V. 1910.1.

Singapore: Raffles Museum; report, 1903. Hanitsch, R. 1904.1.

See also " Notes on Asiatic Museums " *by* B. Dean *in* Pop. Sci. Monthly, 1906, pp. 481–497.

AUSTRALIAN MUSEUMS

Queensland Museum; exhibit. Ogilby, J. D. 1907.1.

EUROPEAN MUSEUMS

Austria-Hungary: *Zagreb Zool. Museum; Cat.* Langhoffer, A. 1904.1.

University of Vienna; Zool.-Comp. Anat. Coll. Werner, Franz. 1904.1.

Salzburg Municipal Museum, notice of. Zetter, J. T. 1859.1.

Belgium and Luxembourg: *Luxembourg Nat. Hist. Museum; cat. Congo fishes.* Boulenger, G. A. 1909.1.

Brussels; Royal Museum; exhibit, fossil fishes. Dupont, E. F. 1887.1.

British Isles: *Bibliography, Museums of United Kingdom.* 3 *vols.* Murray, D. Add. 1904.1.

Bath Museum; list, fossil types. Wilson, E. 1892.1. — *Moore fossil coll., list.* Winwood, H. H. 1905.1.

Brighton Museum; cat., Cretaceous fossils. Willett, H. 1871.1.

Bristol Museum, List, fossil types. Wilson, E. 1890.1.

Cambridge; Geol. Museum Cambridge Univ.; vertebrate fossils. M'Coy, F. 1854.1. — *Woodwardian Museum; cat., type fossils.* Woods, H. 1891.1, 1893.1; Woodward, J. Pre-Linn. 1728.2.

Gosport; Haslar Hospital Museum. Baikie, W. B. Add. 1852.2.

Liverpool Univ. College; cat., fisheries coll. Herdman, W. A. 1897.1; Herdman & Scott, A. 1897.1.

London; British Museum; catalogue. Boulenger, G. A. 1895.2. — *Guides.* Günther, A. C. 1859.1, 1887.2; Ridewood, W. G. 1908.1. — *List.* Gray, J. E. 1851.1. — *Catalogues of fossil coll.* Davies, W. 1871.1; Woodward, A. S. 1885.1, 1889.2, 1904.2, 1905.1. — *Fossil collections of Lord Cole and Sir Philip Grey-Egerton.* Egerton, P. G. 1836.1, 1841.1, 1869.1. — *Linnæan Coll.* Goode, G. B. & Bean, T. H. 1885.4; Günther, A. C. 1899.2. — *L. T. Gronow coll., cat. See also under* Denmark, *below.* Gray, J. E. 1854.1. — *Types American fishes.* Jordan, D. S. 1880.4, 1884.4. — *Museum Petiveriani; description.* Petiver, J. Pre-Linn. 1695.1. — *Catalogue, J. Banks' coll.* Dryander, J. Add. 1796.1.

London; Royal College of Surgeons. — *Teratological series, cat.* Lowne, B. T. 1893.1. — *Fossils; cat.* Owen, R. 1854.1. — *Physiol. series comp. anat., cat.* Owen, R. Add. 1833.1; Stewart, C. Add. 1900.1.

London; Collection of fossils of J. Tennant; catalogue. Woodward, S. P. 1858.1.

Museum of Field Naturalists & Scientific Soc., Malton, Yorkshire; fossil coll. Woodward, A. S. 1889.12.

Manchester; Owens College; catalogue of types and figured specimens in geol. dept. Bolton, H. 1893.1, 1894.1.

Museums — *Cont'd.*

Musæum Tradescantianum. Now in Ashmolean coll., Oxford. First cabinet of natural curiosities in England. Tradescant, J. Pre-Linn. 1656.1.

Norwich Castle Museum, Norfolk; list of fossils. Leney, F. 1902.1.

Dublin Science and Arts Museum. — *Cat., fossils.* Lydekker, R. 1887.1; Davis, J. W. Add. 1888.1. — *Catalogue, local fishes.* Scharff, R. F. 1889.1.

Lord Cole's collection of fossils, at Florence Court, Enniskillen, Co., Fermanagh, Ireland. Cole, W. W. 1869.1; Egerton, P. M. 1836.1; 1841.1.

Edinburgh Museum of Science and Art. — "*Powrie coll.*" *of fossils.* Traquair, R. H. 1892.2. — *Fossil Fishes.* Woodward, A. S. 1898.4,.5, 1899.1.

Denmark: *Museum Gronovii, now in Brit. Museum. See also* Gray, J. *above, under* London. Gronovius, L.T. Pre-Linn. 1754.1.

Museum regium (Copenhagen Museum); cat. Jacobæus, O. Pre-Linn. 1710.1.

Finland, *see below under* Russia.

France: *Musée d'Hist. Nat. d'Elbeuf; fossil fishes.* Coulon, L. 1903.1.

Paris; Muséum National d'Histoire Naturelle. Bernard, P. & others, 1842.1. — *Exhibits of Osteology.* Brühl, C. B. 1856.1, 1887.1. — *Catalogues.* Duméril, A. H. 1858.2; Guichenot, A. 1865.1, 1866.1,.2, 1868.1; Pellegrin, J. 1905.1, 1906.1. — *Guide.* Lacépède, B. 1795.1. — *Accounts.* Marcou, J. 1869.1; Sauvage, H. E. 1880.1–1916.1; Vaillant, L. L. 1890.1. — *Types of Monte Bolca fishes.* Eastman, C. R. 1905.7. — *Types of American fishes.* Jordan, D. S. 1880.4, 1884.4. — *Types of Cuvier.* Jordan, D. S. 1887.7.

Germany: *Berlin; Zoological Museum; types, American fishes.* Jordan, D. S. 1884.4.

Berlin; Märkisches Provinzial Museum; — *fisheries exhibit.* Friedel, E. 1880.1.

Breslau; Mineralogisches Museum; collection Devonian fishes. Gürich, G. 1891.1.

Gottorp Castle Museum, Oldenburg. (Partly removed to St. Petersburg.) Olearius, A. Pre-Linn. 1666.1.

Cat. Repositorium Valentinianum, Giessen. Valentini, M. B. Pre-Linn. 1704.1.

Halle Univ.; history of zoological collections. Taschenberg, E. O. 1894.1.

Munich; PalæontologicalMuseum. Riess, J. A. 1887.1.

Nuremberg; Museum Besleriani; account. Besler. B. Pre-Linn. 1716.1.

Senckenberg; Museum naturforschenden Gesellschaft; collection of fish skeletons. Rüppell, W. P. 1852.1.

Italy: *Collection of Aldrovandi, Bologna. (Still in existence.)* Aldrovandi, U. Pre-Linn. 1648.1.

Ancona; R. Istituto Tecnico; cat. Paolucci, L. 1867.1, 1880.1.

Cremona; Royal Palace; fossil coll. Stefano, G. 1906.1.

Florence; Museo Imperiale di Fisicae Storia Naturale. Martelli, U. 1903.1. — *Collection, G. E. Rumpf.* Targioni-Tozzetti, G. 1903.1.

Genoa; Municipal Museum (Museo Civico di Storia Naturali). Vinciguerra, D. 1879.1. — *Univ. of Genoa; coll.* Pollini, C. 1889.1.

Milano; Museo civico. Bellotti, C. 1878.1, 1890.1.

Naples; Museum of Ferrante Imperato. Imperato, F. Pre-Linn. 1593.1.

Parma; Univ. of; fossil coll. Stefano, G. 1912.1.

Ravenna; Museum Ginanni. Zampieri, C. Add. 1762.1.

Rome; University of Rome. Carruccio, A. 1899.1, 1903.1, 1906.1, 1908.1, 1912.1.

Rome; Kircher's collection, still in Jesuit College. Buonanni, F. Pre-Linn. 1709.1; Kircher, A. Pre-Linn. 1678.2.

Venice; Instituto Veneto di Scienze, Lettere ed Arti. Trois, E. F. 1875.1, 1876.2, .5, 1880.3.

Verona; Museum Fr. Calceolarii; later added to Moscardo's coll. Chiocco, A. Pre-Linn. 1622.1.

Verona; Museum of Conte Lodovico Moscardo. Monte Bolca fishes. Moscardo, L. Pre-Linn. 1656.1.

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Madeira Is.: *Ponta Delgada Museum.* Collett, R. 1897.2.

Monaco: *Musée Océanographique; collection of Selachii.* Roule, L. 1912.2.

Netherlands: *Amsterdam; Museum Sebæ. First Seba museum removed to St. Petersburg by Peter the Great,* 1716; *descr. of second (now dispersed).* Seba, A. Pre-Linn. 1734.1.

Amsterdam; Swammerdam's coll., cat. Swammerdam, J. Pre-Linn. 1679.1.

Haarlem; Musée Teyler; palæontological coll. Winkler, T. C. 1863.1, 1878.1.

Leyden; Muséum d'Histoire Naturelle des Pays-Bas., cat. ostéologique. Lidth de Jeude, T. W. 1898.1.

Portugal: *University of Coimbra.* Vieira, L. 1894.2, 1897.1, 1898.1, 1900.1. 1901.1.

Lisbon; Museu Nacional. — *Catalogues.* Capello, F. de B. 1868.1, 1870.1,.2, 1871.1, 1873.1, 1876.2; Guimarães, A. R. 1884.2, 1885.2. — *Types of albinism.* Seabra, A. F. 1909.1.

Russia: *Finland.* — *Gifts to Finnish Zool. Museum.* Levander, K. M. 1893.1.— *Annual reports.* Mela, A. J. 1886.1–1888.2.

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St. Petersburg; Museum Imperial Academy of Science. Berg, L. S. 1912.2; Jaschschenko, A. P. 1896.1; Koelreuter, J. G. 1761.1. — *For collections brought from other countries by Peter the Great, see* Olea-

rius, *under* Germany (Gottorp), *and* Seba, *under* Netherlands (Amsterdam).

Tiflis; Caucasian Museum; account. Radde, G. F. 1899.1.

Spain: *Madrid; Real gabineté de historia natural.* Bru de Ramon, J. B. 1786.1. *Instituto de Jovellanos.* Jiménez de Cisneros, D. 1904.1. *Sevilla; University Museum.* Calderon y Arana, L. Add. 1889.1.

Sweden: *Stockholm; Museum Adolpho-Friderici, Palace of Ulricsdahl; descriptions.* Balk, L. Pre-Linn. 1749.1; Linnæus, C. Pre-Linn. 1754.1. *Upsala; Univ.* Thunberg, C. P. 1787.1. —*Linnæan type-specimens.* Lönnberg, A. J. 1896.3. —*List of Japanese fishes.* Nyström, E. 1887.1.

Switzerland: *Geneva; Nat. Hist. Museum; fossil fishes.* Woodward, A. S. 1898.5.

NORTH AMERICAN MUSEUMS

Canada: Fisheries Museum; reports. Halkett, A. 1905.3, 1907.1, 1910.2.

Mexico: Museo Nacional; cat. Herrera, A. L. 1896.1.

United States

Connecticut: Yale Univ.; Triassic coll. Eaton, G. F. 1903.1. — *Wesleyan Univ.* Goode, G. B. 1877.1, 1878.12, 1879.4.

District of Columbia: Washington; U. S. National Museum. —*Reports.* Bean, T. H. 1884.9, 1889.18, 1890.25, Add. 1885.1–1893.1. —*Collection of European fishes.* Bean, T. H. 1879.7. —*Selachians.* Garman, S. 1885.4. —*List of publications.* Geare, R. I. 1906.1. —*Fossil coll. List of type specimens.* Merrill, G. P. 1907.1. *Collection of Prof. O. C. Marsh.* Walcott, C. D. 1900.1. —*Fossil fishes.* Eastman, C. R. Add. 1917.3. —*Mounted collection.* Shufeldt, R. W. 1894.2,.3.

Washington: Smithsonian Institution. —*List of publications,* 1846–1903. Rhees, W. J. 1882.1, 1903.1. —*History.* Gill, T. N. Add. 1897.2.

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Texas: University of Texas; list of fossil types. Montgomery, T. H. 1904.1.

SOUTH AMERICAN MUSEUMS

Brazil: — *Rio de Janeiro; Museu Nacional.* Ribeiro, A. 1903.1, 1904.1. — *Para; Museu Goeldi.* Snethlage, E. 1909.1.

Chile: Santiago; Museo Nacional; cat. Quijada, B. 1912.1, 1913.1.

MYOLOGY (*OF FISHES*)

Comprising the structure and development of the muscular system.

For the eye muscles, *see* Oculo-motor apparatus *under* Eye.

The heart muscles are included with and treated *under* Heart.

For the electrical organs, which are derivatives of, or which are transformed muscles, *see under* Electrical Fishes.

For the general function of the muscles, *see under* Locomotion.

For technique in the study of muscular contraction in respiration, *see under* Technique and Methods.

For the chemical composition of the muscles, *see* Analysis of flesh *under* Chemistry.

For an excellent treatise in English on the musculature of the salmon which may be used as a manual for the dissection of the muscles of a typical bony fish or teleost, see ★Greene, C. W. & Greene, C. H. Add. **1914.1.**

Another valuable paper, on the myology of Amiurus, is ★McMurrich, J. P. 1884.1.

Development of muscles

For an excellent general account, in German, of the development of the muscular system, with a full bibliography, see ★Maurer, F. **1906.1**.

Miscellaneous and general. Balfour, F. M. 1877.1; ★Braus, H. 1898.1, **1899.1**; Gad, - 1877.1; Lebert, H. 1849.1; ★Maurer, F. 1894.1–1912.1; Schmalhausen, J. J. 1912.1 (i). —*Early stages in differentiation of myotome and sclerotome.* ★Sunier, A. L. J. 1911.1.

Development of the muscles in various fishes. —*Elasmobranchii.* Kastschenko, N. 1890.2; Schneider, A. F. 1890.2; ★Kaestner, S. Add. 1892.1. — *Petromyzon* ★Schiefferdecker, P. 1911.1. — *Teleostei.* Vialleton, L. 1902.3.

Histology of striated muscle

Miscellaneous and general. Baumhauer, E. H. 1848.2; Bornaud, E. 1887.2; Emery, C. 1881.1; ★Hirschler, J. 1910.1; ★Länsimäki, T. A. 1910.1; Munk, H. 1858.1; Leeuwenhoek, A. Pre-Linn. 1723.1.

Myology — *Cont'd.*

Muscle fibers preserved in the Devonian fossil, Cladoselache. Dean, B. 1901.4, 1902.3.

Phylogenesis of striated muscle fibers. Maurer, F. 1900.1. — *Muscle fibers, regeneration.* Schmincke, A. 1907.1.

Continuity of muscle fiber and tendon. Schultze, O. 1911.1.

Degeneration of muscle fibers and their function as connective tissue in embryonic selachians. Thulin, I. 1914.1.

Structure of striated muscle in various fishes. — *Trout.* ★Heidenhain, M. 1913.1, .2. — *Petromyzon.* Keferstein, W. M. 1859.2. — *Rays.* Ranvier, L. A. 1873.1. — *Petromyzon.* Renaut, J. & Dubreuil, G. 1905.1.

For the occurrence of striated muscle fibers in the intestine of certain teleosts, see Tunica muscularis *under* Alimentary canal.

Innervation of striated muscle

Being chiefly the peripheral terminations of motor nerves in the voluntary or striated muscle fibers. Baglioni, S. 1909.1; Belousov, N. 1909.1; Bisselick, J. W. 1905.1; Boeke, J. 1902.2, 1908.2; Cavalié, M. 1902.1, 1904.3; Ciaccio, G. V. 1877.2, .3, 1882.1, 1883.1; Fusari, R. 1901.1, 1905.1; Giacomini, E. 1898.2,.3; ★Huber, G. C. & De Witt, L. 1898.1; Kallius, E. 1897.1; Razzauti, A. 1914.1; Retzius, M. G. 1892.7; Supino, F. 1898.1; Trinchese, S. 1892.1; Wikström, D. A. 1897.1, 1903.1.

Demonstration of continuity between nerve cell and muscle cell from the very first separation of the two sets of elements (Lepidosiren). Kerr, J. G. 1902.1, 1904.2.

Innervation of striated muscles by sensory nerves. Poloumordwinoff, D. 1899.1, 1902.2; Wunderer, H. 1908.1.

ANATOMY OF MUSCLES

Musculature in general

The following references, in general, include the complete muscular system, *i. e.,* both cranial and body musculature.

Miscellaneous and general. Baudelot, E. 1867.1; Carlisle, A. 1805.1; ★Jaquet, M. 1897.2; Kuhl, H. & Hasselt, J. K. 1820.1, 1824.1.

Muscular system of Amphioxus. Grenacher, H. 1867.1; Rhode, E. 1892.1.

Anatomy of muscles of Cyclostomata. — *Myxinidæ.* Cole, F. J. 1905.1 (ii). — *Cyclostomata.* Grenacher, H. 1867.1. — *Petromyzon.* Stannius, F. H. 1851.1.

Structure of the muscles in Elasmobranchii. Chaine, J. 1902.1. — *Mustelus.* Humphry, G. M. 1872.3. — *Raja.* Ranvier, L. A. 1873.1.

Morphology of the muscles in Ganoidei and Dipnoi. — *Polyodon.* Danforth, C. H. 1913.1; Handyside, P. D. 1875.1 (ii). — *Neoceratodus and Protopterus.* Humphry, G. M. 1872.1.

Structure of the muscles in various Teleosts. — *Salmo.* Bruch, C. W. 1861.3. — *Malopterurus.* Cleland, J. 1858.1. — *Plectognaths.* Rosén, N. 1912.1 (iv). — *Carassius.* Schiefferdecker, P. 1909.1. — *Luvarus.* Haller, B. Add. 1881.1.

MYOMERES OR MYOTOMES

The muscle-masses of Teleosts are composed on each side of a series of transverse segments (myomeres) which are separated from each other by bands or fasciæ of fibrous connective tissue (myosepta or myocommata).

Variation in form or shape and arrangement of myomeres. Anderson, R. J. 1889.1; Dietz, P. A. 1909.1, 1913.1; Houssay, F. 1909.2, 1912.2; Wikström, D. A. 1897.1, 1903.1.

Trunk-myotome form in Petromyzon and Acanthias. Langelaan, J. W. 1904.1. — *Trunk-myotome form as influenced by fins.* Tricht, B. 1907.1,.2.

Actual counts of the number of myomeres in numerous adult selachians and teleosts. Magnan, A. & La Riboisiere, J. 1912.1.

Cranial and visceral muscles

Muscles with their insertions in the jaws and visceral arches and serving to move these structures. Inclusive of mandibular and pharyngeal muscles.

A noteworthy treatise on the cranial and visceral musculature of Amia, with magnificent illustrations, is that of ★Allis, E. P. **1895.1,** 1898.2.

For a general treatise on the embryological development and homologies of the cranial muscles of vertebrates including fishes, see ★Edgeworth, F. H. **1911.1.**

For an illuminative paper in English on the morphology of the visceral muscles of Selachii, see ★Marion, G. E. 1905.1.

A recent treatise summarizing the homologies of the several jaw muscles throughout the vertebrate series is ★" A memoir on the phylogeny of the jaw muscles in recent and fossil vertebrates " *by* L. A. Adams. Ann. N. Y. Acad. Sci., 1919, *vol.* 28, *pp.* 51–166, *pls.* i-xiii.

Muscles of the jaws, adductor and depressor mandibulæ, etc., respectively closing and opening the mouth. They include as parts, the M. constrictor I. dorsalis (M. levator maxillæ superioris), M. levator palatoquadrati, M. spiracularis, etc. These muscles are innervated by the trigeminal and facial nerves.

Structure in Elasmobranchii (sharks and rays). Edgeworth, T. H. 1902.1; Fürbringer, M. 1895.1; ★Luther, A. F. 1909.3, **1913.2;** Marion, G. E. 1905.1; ★Tiesing, B. 1895.1.

Structure in Teleostei. Arcangeli, A. 1911.1; Ayres, W. O. 1848.5; Chaine, J. 1904.1, 1905.2; ★Vetter, B. 1878.1; ★Dietz, P. A. 1912.2, Add. **1914.1.** — *Gadus.* ★Holmquist, O. 1911.1. — *Silurus glanis.* ★Juge, M. 1899.1.

Structure in — Cyclostomata. Fürbringer, P. 1874.1, 1875.1. — *Dinichthys.* Gregory, W. K. 1915.2. — *Amia.* McMurrich, J. P. 1885.1. — *Hypoglossus musculature, development.* Neal, H. V.

1897.1. —*General.* Teutleben, E. Add. 1874.1.

Branchial or respiratory musculature, or the mechanism for opening and closing the gill clefts, including both internal and external interbranchials. The preceding references also include this subject. Albrecht, P. 1876.1; Bazin, A. 1839.2,.3; Borcéa, J. 1907.1,.4; Favaro, G. 1902.1; McWilliam, J. A. 1885.1; Remak, R. 1843.1.

Musculus protractor hyoidei (M. geniohyoideus, auct.), extending from ceratohyal to symphysis of dentary. ★Albrecht, P. 1876.1; Anderson, R. J. 1881.1; Chaine, J. 1900.2, 1901.1; ★Holmquist, O. 1910.1, 1911.1, 1913.1, Add. 1910.1; Rouvière, H. Add. 1906.1; Zavattari, E. Add. 1910.1.

Limb and trunk muscles

By morphologists (Gegenbaur, Kingsley et al.) the trunk musculature is regarded as divisible horizontally into dorsal (epaxial) and ventral (hypaxial) portions, the line of division being marked by a horizontal partition of connective tissue.

The following references, chiefly to teleosts, include in general the structure of the entire trunk musculature including the muscles of the fins. ★Chevrel, R. **1913.1**; Greene, C. W. 1913.1; Hartmann, R. 1881.1; Hindersson, H. A. 1910.1; Knauer, F. K. 1910.1; ★Maurer, F. 1892.1–1912.1; Reichert, C. B. 1871.1; Schmalhausen, J. J. 1912.1 (ii).

Musculature of dorsal fin in — Motella. Bogoljubsky, S. 1908.1 — *Hippocampus.* Ranvier, L. A. 1874.1; Rollett, A. 1888.1; Schultze, O. 1911.1.

Supracarinales of Teleostei. Favaro, G. 1902.2. — "*Rectus abdominis*" *of Petromyzon.* Schneider, A. F. 1882.1.

Dorso-ventral division of lateral muscles considered empirical, and lateral muscle in teleosts regarded as composed of a single layer. Shann, E. W. 1914.1.

MYTHOLOGY AND SYMBOLISM

For the Christian fish symbol, *see under* Theology.

For a valuable recent work in English, treating extensively the mythology and symbolism of fishes among the Greeks and Romans, Egyptians, and Assyrians, see ★Wm. Radcliffe, "Fishing from the earliest times," London. 1921. 478 p.

General treatises. Folk-lore and legends; fictitious and mythical fishes, etc. ★Gubernatis, A. 1872.1; Hulme, F. E. 1895.1; ★Robinson, P. S. 1883.1; Vinycomb, J. 1906.1; Watkins, M. G. 1896.1; Sebillot, P. Add. 1901.1.

The great sea-serpent, its identification with fishes. Collett, R. 1884.1; Holder, C. F. 1903.3; Holder, C. F. & Jordan, D. S. 1913.1; ★Oudemans, A. C. 1893.1; Smith, H. M. 1904.1; Anon. 496.

Fishes as mystic symbols in China and Japan. Carus, P. 1911.1; Laufer, B. 1912.1. —*Fish symbol of Egyptian paintings.* Mahler, E. 1913.1. —*Fish and water symbols.* Norwood, J. W. 1912.1. — *The fish as a sexual symbol.* Eisler, R. Add. 1914.1.

Ichthyophobia or taboo of fish. Matthews, W. 1898.1. —*Fish totems in Torres Straits and New Guinea.* Haddon, A. C. & Rivers, W. H. Add. 1904.1; Seligmann, C. G. Add. 1910.1. —*Fishing myths and ceremonies in the Malay Peninsula.* Skeat, W. W. Add. 1900.1.

Hieroglyphics or markings believed or alleged to have been found on fishes. Pre-Linn. *refs.* Bartholinus, T. 1654.1; Döbel, H. W. 1718.1; Francus, A. 1591.1; Jeraucurius, A. 1588.1; Simson, A. 1622.1.

Miscellaneous papers on mythology. Anon. 738; Eckstein, K. Add. 1911.1. — Pre-Linn. *refs.* Castrillo, H. 1692.1; Kornmann, H. 1666.1; Lemnius, L. 1559.1; Picinelli, D. F. 1670.1; ★Rondelet, G. 1558.1; Vogelhaupt, J. 1670.1. — "*Trees producing fish.*" Duret, C. 1605.1.

Fishes in heraldry. *Use of fishes in armorial bearings, seals, etc.* Robinson, P. S. 1883.1; ★Moule, T. Add. **1842.1**; Schulenberg, W. Add. 1911.1; Peacham, H. Pre-Linn. 1627.1.

Myth of the shipholder. The "shipholder" (Remora or Echeneis) was believed by ancient mariners to be the cause of the retardation or the standing still of ships even when under full sail in a good breeze. This phenomenon is now known to be caused by "dead-water" which is due to a layer of fresh or brackish water resting upon the denser sea water. A vessel moving in such a place creates waves in the boundary between the two water-layers whose conflicting currents stay the ship.

For the first scientific explanation of this phenomenon, see Ekman, V. W. 1906.1.

For a full review of all the known literature on this myth, with reproductions of early figures, see E. W. Gudger, *in* Ann. Mag. Nat. Hist. 1918, ser. 9, vol. 2, pp. 271–305; 1919, ser. 9, vol. 4, pp. 17–21.

NERVOUS SYSTEM

Comprising the morphology, development and physiology of the nervous mechanism.

Many of the parts of the nervous system have been treated separately. *See* Auditory organs, Brain, Eye, Gustatory organs, Lateral line system, Olfactory organs, Spinal cord, etc.

Anatomy and morphology in general. Reference should also be made to the various subdivisions of the nervous system below for the literature relating specifically to these constituent parts.

General treatises. Baudelot, E. 1883.1; Girgensohn, O. G. 1846.1; ★Johnston, J. B. **1906.1**, 1907.1, 1913.1; Key, A. & Retzius, G. 1875.1.

Miscellaneous and general. Apáthy, S. 1895.1; Bailly, E. M. 1824.2; Bazin, A. 1839.4; Bellonci, G. 1880.1; Cortese, F. 1846.1; Desmoulins, L. A. 1822.1,.2,.3; Dubreuil, E. 1885.1; Ebel, J. G. 1788.1;

Nervous System — *Cont'd.* Fenner, C. W. 1835.1; Le Boux, M. 1887.1; Le Roux, M. F. 1887.1, Add. 1889.1; Swan, J. 1835.1; Treviranus, G. R. 1820.1; Zaghorskii, A. P. 1833.1; Wittzack, J. C. 1817.1.

Amphioxus. ★Heymanns, J. F. & Stricht, O. **1898.1**; Quatrefages, J. L. 1845.1; Rhode, E. 1892.1; Schneider, A. F. 1880.2.

Cyclostomata. — *Petromyzontidæ.* Ahlborn, C. G. 1882.1, 1883.1; Alton, E. & Schlemm, F. 1838.1; Desmoulins, L. A. 1824.1, 1825.2. — *Myxine.* Retzius, A. J. 1822.1–1828.1; Sanders, A. 1894.1.

Dipnoi and Ganoidei. — *Polyodon.* Handyside, P. D. 1875.1. — *Protopterus.* Wiedersheim, R. E. 1880.2.

Elasmobranchii. Onodi, A. D. 1886.1; ★Savi, P. **1844.1**; Szczawinska, W. 1898.1.

Teleostei. Gehuchten, A. 1894.1; Le Roux, M. 1887.1. — *Cyprinus.* Büchner, G. 1835.1. — *Lepadogaster.* Guitel, F. 1887.3. — *Argyropelecus.* Handrick, K. 1901.1. — *Amiurus.* Wright, R. R. 1885.3.

Development and embryology. — *Squalus.* Neal, H. V. 1915.2. — *Petromyzon.* Shipley, A. E. 1886.1. — *Transient nervous system.* — *Selachii.* ★Beard, J. 1892.2, **1896.1**,.3,.4; Dohrn, A. 1882.2 (xvii). — *Trout.* Rohon, J. V. 1884.1.

Epibranchial placodes. Landacre, F. L. 1908.1, 1912.1.

For other transient nervous structures, see also Giant ganglion cells *under* Spinal cord.

Histology. *General treatises.* Hannover, A. 1844.1; Lenhossék, M. 1894.1, 1895.1; ★Ramon y Cajal, S. **1899.1**.

In various fishes. — *Myxine.* Holm, J. F. 1901.1. — *Teleosts.* Le Roux, M. 1887.1. — *Branchiostoma.* Quatrefages, J. L. 1845.1.

Physiology *of the nervous system. For effects of extirpation of cerebrum, medulla, etc., see* Physiological researches *under* Physiology.

For a comprehensive review of the physiology of the nervous system in all vertebrates, see ★Baglioni, S. Add. 1910.1.

General treatises. Girgensohn, O. G. 1846.1; ★Polimanti, O. **1911.3**, 1913.1; Vulpian, E. F. 1864.1.

Miscellaneous and general. Bailly, E. M. 1824.2; Desmoulins, L. A. 1822.1, .2,.3; Flourens, M. J. 1825.1; Treviranus, G. R. 1820.1. — *Oxygen metabolism.* Baglioni, S. 1905.2; Buijtendijk, F. J. 1910.1. — *Branchiostoma.* Polimanti, O. 1910.1.

COMPONENTS OF THE NERVOUS SYSTEM

GANGLIA AND GANGLION CELLS

It has been found impossible to separate Cranial and Spinal ganglia and ganglion cells from those belonging to the peripheral nervous system.

For ganglia of particular nerves, *see* those nerves *under* Peripheral nervous system.

Development and histology. Beard, J. 1892.1; ★Dohrn, F. A. **1882.2** (xvii); Schaffer, J. 1896.3; Schenk, S. L. 1877.1; Schultze, H. 1878.1. — *Lophius.* Antoni, N. 1907.1. — *Amphioxus.* Boeke, J. 1907.3. — *Selachii.* ★Gast, R. **1909.1.** — *Raja.* Robin, C. P. 1847.5.

Occurrence of canals and alveoli in ganglion cells. Studnička, F. K. 1903.1, Add. 1899.1.

Cranial ganglia. *Anatomy.* Beard, J. 1885.1, 1888.2. — *Salmon embryos.* Fürst, C. M. 1900.2, 1901.1. — *Amphioxus.* Johnston, J. B. 1905.1.

Development. — *Elasmobranchii.* Beard, J. 1888.2; Guthke, E. 1906.1 (*Torpedo*); Klinkhardt, W. 1905.1; ★Mitrofanov, P. I. **1892.1.**

Development of cranial ganglia, Ameiurus. Landacre, F. L. 1910.1.

Cerebro-spinal ganglia. *Histological structure.* Levi, G. 1906.1; Retzius, M. G. 1880.2, (*Myxine*) 1890.2. — *Petromyzon.* Tomaselli, A. 1907.1. — *Selachii.* Cannieu, - Add. 1899.1.

Spinal ganglia and ganglion cells. *Structure and development.* Gehuchten, A. & Nelis, C. 1898.1; Holmgren, A. E. 1899.1, 1900.1; Kolster, R. 1899.2; Levi, G. 1911.1; ★Neumayer, L. **1906.1**; Rawitz, B. 1882.1. — *Petromyzon.* Freud, S. 1879.1. — *Amphioxus.* Johnston, J. B. 1905.1. — *Cyclostomes.* Mawas, J. 1910.2.

Elasmobranchii. — *Pristiurus.* Lenhossék, M. 1892.1. — *Raja.* Wahlgren, F. 1852.1.

Teleosts. Trinci, G. 1905.1. — *Salmon.* Fürst, C. M. 1900.2, 1901.1. — *Lophius.* ★Holmgren, A. E. 1899.2. — *Perca.* Kolster, R. 1898.2.

Development of neural crest, out of which are formed dorsal spinal ganglia. Coggi, A. 1895.1,.2; Dohrn, F. A. 1882.2 (xx), 1892.1.

Sympathetic ganglia. *Anatomy and morphology.* ★Huber, G. C. 1897.1, Add. **1899.1.** — *Elasmobranchii.* Diamare, V. 1902.1; Pitzorno, M. 1910.1–1913.1. — *Of heart, Sharks and Teleosts.* Vignal, W. V. 1880.1, 1883.1.

Incertæ sedis. "*Ganglienleiste,*" *structure of.* Boeke, J. 1903.1; Dohrn, F. A. 1882.2 (xxii); Froriep, A. 1901.1.

Miscellanea. — *Ganglion isthmi.* Johnston, J. B. 1905.4. — *Froriep's ganglion.* Ostroumov, A. A. 1889.2. — *Subcutaneous ganglion cells, Myxine.* Retzius, M. G. 1890.2. — *Sensory ganglia, histology.* Chase, M. R. Add. 1909.1. — *Anterior ganglionic cord, Torpedo and Pristiurus.* Coggi, A. 1895.2.

NERVES

Morphology and development. Büchner, G. 1836.1,.2; Harrison, R. G. 1906.1. — *Petromyzon.* Dohrn, F. A. 1882.2 (xiii). — *Nerves without ends.* Hyrtl, C. J. 1863.1. — *Lophius.* Raffaele, F. 1900.1.

Nerves classified on a functional basis. *Motor nerves.* — *Viscero-motor*

roots, Amphioxus. Johnston, J. B. 1905.1. — *Motor nuclei, arrangement in Chimæra.* Kappers, C. U. 1912.1. — *Development, Lepidosiren.* Kerr, J. G. 1902.1, 1904.2. — *Structure and functions.* Moreau, F. A. 1859.1, 1860.3, 1861.1.

For motor nerve terminations, see Myology, Innervation of striated muscle.

Sensory nerves. — *Structure and functions.* Moreau, F. A. 1859.1, 1860.3, 1861.1.

For sensory nerve terminations in striated muscle, see such heading under Myology.

Electrical nerves, see under Electrical fishes.

Nerve plexuses. — *Relations of pectoral and dorsal fin plexuses.* Fürbringer, M. 1879.1. — *Nerve plexuses, Elasmobranchii.* Braus, H. 1910.2, 1911.1. — *Trigemino-facialis plexus in Lota.* Goronowitsch, N. 1897.2. — *Nervus collector in teleosts.* Hammarsten, O. D. 1909.1; Punnett, R. C. 1900.1, 1901.1.

For segmental structure of motor nerve plexus, see under Metamerism.

Nerve tissue. *Histology and development.* Beard, J. 1892.1; Bornaud, E. 1887.1. — *Ganoidei and Teleostei.* Nemiloff, A. 1908.1; Sterzi, G. 1911.1.

For a comprehensive treatise on the tissues of the nervous system, *see* Held, H. 1909.1.

Nerve cells. *Histological structure.* Flemming, W. 1896.1; Held, H. 1896.1; Jacobsohn, L. 1910.1; Paladino, G. 1898.1; Schultze, H. 1878.1; Retzius, M. G. 1911.3. — *Petromyzon.* Kolster, R. 1898.1 (ii), (*Cottus*) 1900.1; — *Ganoidei and Teleostei.* Nemiloff, A. 1908.1. — *Chondrostei.* Valenti, G. 1891.1.

Various researches. — *Vacuolisation of nerve cells.* Athias, - 1906.1. — *Intracortical fibers.* Bottazzi, F. 1893.1. — *"Myelocytes."* Chatin, J. 1889.2. — *Nature of pericellular network.* Hatai, S. 1903.1. — *Neurone, significance of size.* Johnston, J. B. 1908.3. — *Teleneurones in Leuciscus.* Hoffmann, C. K. 1897.1. — *Intracellular fibrils, Lophius.* Holmgren, A. E. 1903.1; Mencl, E. (*Scyllium*) 1903.3. — *Physiology of nerve cells.* Jacobsohn, L. 1910.1. — *Nomenclature of nerve cells.* Nissl, K. 1895.1. — *Development of nerve cells in Selachii.* Pighini, G. 1905.1. — *Sensory cells of Golgi.* Ramon y Cajal, P. 1897.1. — *Canals and alveoli in axis cylinder.* Studnička, F. K. Add. 1899.1.

Nerve fibers or neurofibrils. *Histological structure.* Auerbach, L. 1912.1; Babukhin, A. I. 1868.1; Nemiloff, A. 1910.1; Retzius, M. G. 1910.1; Schultze, H. 1878.1. — *Significance of size.* Herrick, C. J. 1902.2. — *Neurofibrillar continuity.* Held, H. 1905.1.

Nerve fibres in ganglion cells. Bethe, A. 1900.1. — *Amphioxus.* Boeke, J. 1902.2. — *In retinal ganglia, Selachii.* Schnaudigel, O. A. 1905.1.

Origin and development. Babukhin, A. I. 1868.1; Neal, H. V. 1915.2.

NEUROGLIA

(Connective tissue cells of a supporting character).

Histological structure. Bonome, A. 1907.1; Catois, E. H. 1898.1; Fano, C. 1906.1; Mawas, J. 1910.1; Müller, E. 1899.1; Retzius, M. G. 1893.3; Sala y Pons, C. 1894.1; Terry, R. J. 1907.1; Valenti, G. 1891.1. — *Neuroglia in retina.* Sacchi, J. 1884.1.

Ependyma, *columnar epithelial neuroglia cells which line the cavity of the central nervous system.* — *Structure.* Franz, V. 1912.1; Retzius, M. G. 1891.4, 1893.3; Stendell, W. 1914.5; ★Studnička, F. K. 1899.2, **1899.5.**

Ependymal grooves, including subcommissural organ. Structure and development. Dendy, A. 1913.1, (*Function*) Add. 1909.1; Nicholls, G. E. 1912.2; Sargent, P. E. 1903.1.

CENTRAL NERVOUS SYSTEM

See also Brain, and Spinal cord, indexed separately because of the great number of citations under each.

System of nomenclature based on functional divisions. Johnston, J. B. 1902.1.

Blood vessels of the central nervous system. Sterzi, G. 1907.1.

Anatomy and morphology. *General treatise.* ★Johnston, J. B. **1909.1.** — *Cyclostomata and Selachii.* ★Sterzi, G. **1907.1.**

Miscellaneous papers. Arsaky, A. 1813.1, 1836.1; Meckel, J. F. 1836.1; Sanders, A. 1878.1; Treviranus, G. R. 1820.1.

Anatomy and morphology in various groups of fishes. — *Amphioxus.* Ovsyannikov, F. V. 1868.1; Retzius, M. G. 1891.2; Steiner, J. 1886.3.

Cyclostomata. — *Petromyzon.* Desmoulins, L. A. 1825.1; Mayer, F. 1897.1. — *Myxine.* Retzius, M. G. 1891.3.

Dipnoi and Ganoidei. — *Dipnoi* (*Protopterus and Ceratodus*). Burckhardt, C. R. 1891.2, 1892.2, 1905.1; ★Bing, R. & Burckhardt, C. 1905.1; Sanders, A. 1889.1. — *Polypterus.* Waldschmidt, J. 1887.1.

Elasmobranchii. Rohon, J. V. 1877.1; Sanders, A. 1887.1; Steiner, J. 1886.2, .3. — *Torpedo.* Borchert, M. 1903.1, 1905.1, 1906.1. — *Scymnus.* ★Burckhardt, C. R. **1907.1,** (*Palæo-selachii*). 1911.1. — *Chimæra.* Valentin, G. G. 1842.2.

Teleostei. Grette, A. 1879.1; Stieda, L. 1868.1, 1870.1. — *Orthagoriscus.* Haller, B. 1891.1; Tagliani, G. 1894.1, 1895.1.

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Special researches. Peter, K. 1901.1. — *Teleostei.* Goette, A. 1873.1 (iii), 1878.2; Goronowitsch, N. Add. 1884.1. — *Central canal.* Rudnev, V. G. 1894.1. — *Earliest differentiation.* Schaper, A. Add. 1897.1.

Nervous System — *Cont'd.*

For formation of Medullary tube, *see that heading under* Embryology.

Histology. *For a general account of the histological structure of the central nervous system, see* ★Nansen, H. **1887.2**.

Histological structure of the central nervous system in —*Lophius.* Fritsch, G. T. 1886.4. —*Amphioxus.* Joseph, H. 1904.1. —*Myxine.* Nansen, F. 1885.1, 1886.1. —*Esox.* Neumayer, L. 1895.1.

Meninges, *membranes covering the central nervous system.* — *Pigmentation of sheath.* Borchert, M. 1904.1. —*Membrana limitans externa.* Retzius, M. G. 1904.2. —*Meninx primitiva.* Sagemehl, M. 1884.1 (ii). —*Ontogeny, phylogeny and anatomy.* ★Sterzi, G. 1899.1–1902.2.

Phylogeny *of central nervous system.* Burckhardt, C. R. 1907.1; Gaskell, W. H. 1889.1,.2; Herrick, C. J. 1910.1; Steiner, J. 1888.1.

Reissner's fiber, *a cord of fibers arising in the tectum opticum of the mid-brain and extending backward throughout the central canal of the central nervous system.*

For the most comprehensive study of the structure and development of Reissner's fiber, see ★Nicholls, G. E. **1912.2**.

Anatomy, development, functions, etc. Ayers, H. (*Myxinoidei*) 1908.1; Dendy, A. 1913.1, Add. 1909.1; Studnička, F. K. 1899.1.

Experimental investigations indicating functions as an aid in the flexure of the body. Nicholls, G. E. 1912.1.

Considered an optic reflex apparatus for transmission of motor reflexes. ★Sargent, P. E. 1900.1, 1901.1, **1904.1**, Add. 1901.1.

PERIPHERAL NERVOUS SYSTEM

For the innervation of particular organs, *see under* those organs, such as Electrical organs *under* Electrical fishes, Heart, Striated muscles *under* Myology, etc.

For peripheral terminations of nerves of special senses, *see* Auditory organs, Eye, Gustatory, Olfactory *and* Tactile organs.

For the "End organs," *see under* Senses and Sense organs, *and* Lateral line system.

For a general treatise on the anatomy and physiology of the peripheral nervous system, see Stannius, H. 1849.1.

Anatomy and morphology in various fishes. —*Amphioxus.* Dogiel, A. S. 1903.1; Fusari, R. 1889.1; Kutchin, H. L. 1913.1. —*Ammocœtes.* Julin, C. 1888.1. — *Teleostei.* Herrick, C. J. 1899.3; Stannius, F. H. (*Gadus*) 1842.2; Panschin, B. A. 1910.2. —*Selachii.* Müller, E. 1913.1.

Development. Beard, J. 1888.3, 1890.2; His, W. 1879.1; Kerr, J. G. (*Lepidosiren*) 1910.5; ★Lenhossék, M. 1905.1; Müller, E. (*Selachii*) 1913.1.

Histogenesis. ★Harrison, R. G. **1901.1**; Kolster, R. 1899.1; ★Neumayer, L. **1906.1**.

Phylogenetic relations. Herrick, C. J. 1910.1.

CRANIAL NERVES

General treatises. Gaskell, W. H. 1889.2; ★Johnston, J. B. **1902.4**.

Anatomy and morphology. Cole, F. J. 1898.1,.3, 1899.1; Gaskell, W. H. 1888.1. —*Entrance of cranial nerves into medulla oblongata.* Droogleever Fortuyn, A. B. 1913.1. —*Spinal homologues of cranial nerves.* McMurrich, J. P. 1902.1.

Cyclostomata. Johnston, J. B. (*Petromyzon*) 1905.2, 1908.1; Worthington, Julia (*Bdellostoma*) 1905.2.

Dipnoi. Pinkus, F. 1905.1. —*Ceratodus.* Beauregard, H. 1883.1; Wijhe, J. W. 1882.1. —*Protopterus.* Humphry, G. M. 1872.2; ★Pinkus, F. **1894.1**.

Elasmobranchii. Ewart, J. C. 1889.1; Ewart, J. C. & Cole, F. J. 1895.1; Marshall, A. M. 1881.1; Pinkus, F. 1905.1. — *Raja.* Bonsdorff, E. J. 1857.1. —*Chimæra.* Cole, F. J. 1896.1, 1897.1; Cole, F. J. & Dakin, W. J. 1906.1. —*Torpedo.* Ewart, J. C. 1890.1. —*Hexanchus.* Gegenbaur, C. 1871.1. —*Chlamydoselachus.* Hawkes, O. A. 1906.1. —*Echinorhinus.* Jackson, W. H. & Clarke, W. B. 1876.1. —*Scyllium.* Marshall, A. M. & Spencer, W. B. 1881.1. —*Acanthias.* Meek, A. 1909.1; Strong, O. S. 1903.1.

Ganoidei. ★Wijhe, J. W. 1880.1, 1882.1. —*Amia.* Allis, E. P. 1895.1, 1898.2. —*Acipenser.* Goronowitsch, N. 1888.1; ★Johnston, J. B. 1898.1,.2.

Teleostei. Herrick, C. J. 1897.1, 1898.1. —*Scomber.* ★Allis, E. P. **1903.4**; Dewitz, J. 1904.1. —*Gadus.* Cole, F. J. 1898.1, 1900.1; Herrick, C. J. 1900.1. —*Cyclothone.* Gierse, A. 1904.1. —*Menidia.* ★Herrick, C. J. **1899.1**.—*Siluridæ.* **1901.1**; ★Juge, M. **1899.1**. —*Esox.* Panschin, B. A. 1910.1. —*Macruridæ.* Pfüller, A. 1914.1.

For segmental arrangement and value of cranial nerves, see Metamerism.

Development. ★Goette, A. **1914.1**; Kupffer, C. W. 1891.1; Strong, O. S. 1891.1. —*Phylogeny.* Gaskell, W. H. 1898.1 (x), 1899.1.

Elasmobranchii. —*Chlamydoselachus and Spinax.* Brohmer, P. 1909.1; Guthke, E. 1906.1 (*Torpedo*); Marshall, A. M. 1881.1; ★Mitrofanov, P. I. **1892.1**; Wijhe, J. W. 1882.2.

Teleostei. ★Barbieri, C. 1907.2, 1908.4; Goronowitsch, N. 1897.1, 1898.1.

Origin *in the cells of the brain.* ★Ahlborn, C. G. **1884.1** (*Petromyzon*); Duméril, A. M., Flourens, M. J. & Duvernoy, G. L. 1854.1; Duvernoy, G. L. 1854.1; Goette, A. 1913.1; Philipeaux, J. M. & Vulpian, E. F. 1853.1; ★Wallenberg, A. 1907.1,.2.

Peripheral distribution of cranial nerves. *In various fishes.* — *Ammocœtes.* Alcock, R. 1898.1; Cole, F. J. 1898.2. — *Mustelus.* Allis, E. P. 1901.1. — *Unsymmetrical distribution of cranial nerves.* Collinge, W. E. 1895.3.

For the peripheral distribution of the nerves of special senses, see under organs of

special senses, as Auditory organs, Eye, Gustatory organs, Olfactory organs, Tactile organs.

See also Lateral line system, *and* Sensory organs.

Cranial nerves
by name and number

Abducens (VI). *Anatomy and morphology.* — *General treatise.* ★Neal, H. V. 1912.1, Add. **1914.1.** — *Ganoidei.* Schneider, H. 1881.1. — *Ameiurus.* Workman, I. S. 1900.1.

Motor nuclei, Lophius. Droogleever Fortuyn, A. B. 1909.1; Kappers, C. U. & Fortuyn, A. B. Add. 1909.1.

Auditory (VIII). (*For peripheral terminations of auditory nerve in membranous labyrinth of ear, see under* Auditory organ.)

Anatomy and development. Camper, P. 1763.1, 1774.1; Holmes, G. M. 1903.1. — *Acustico-lateral system, Bdellostoma.* Ayers, H. & Worthington, J. 1908.1. — *Structure of ganglion cells of N. acustico-facialis, Ammocœtes.* Herms, E. 1885.1. — *Development.* Cameron, J. & Milligan, W. 1910.1.

Origin of auditory nerve in cells of brain. — *Teleosts.* Mirto, D. 1895.1, 1896.1. — *Petromyzon.* Rohon, J. V. 1882.1.

Phylogeny. Gaskell, W. H. 1898.1 (x); Kappers, C. U. 1909.1.

Physiology. — *Of vestibular branch of eighth nerve.* Carazzi, D. 1898.1. — *Effect of sectioning auditory nerve, Trigla.* Polimanti, O. 1913.2.

Facialis (VII). *Anatomy and morphology.* Friant, A. Add. 1879.1. — *Motor nucleus of facialis, Lophius.* Droogleever Fortuyn, A. B. 1909.1; Fortuyn, A. B. 1909.1,.2; Kappers, C. U. & Fortuyn, A. B. Add. 1909.1. — *Spinal ganglion of facialis.* Haller, B. 1910.1. — *Peripheral termination.* ★Ruge, G. H. **1897.1.**

Phylogeny of facialis nerve. Gaskell, W. H. 1898.1 (iv); Kappers, C. U. 1909.1; Sheldon, R. E. 1909.2.

Branches of Facialis or VII nerve. *Chorda tympani branch.* — *Chimæra.* Cole, F. J. 1896.1. — *Comparative anatomy.* Froriep, A. 1887.1. — *Homologies in Selachii.* Green, H. A. 1900.1. — *Phylogeny.* Sheldon, R. E. 1909.2.

Gustatory branch of communis system of facialis. — *Relation to nerves of touch.* Herrick, C. J. 1906.3. — *Origin, Cyprinus.* Weber, E. H. 1827.7.

Other branches. — *Mandibularis externus facialis, variations, Gadus.* Holmquist, O. 1913.2. — *Horizontal branch, phylogeny.* Kappers, C. U. 1908.3. — *Lateralis branch, Mormyridæ.* Stendell, W. 1914.4. — *Buccal nerve, variation in origin.* Turner, W. 1867.2.

Glossopharyngeal (X). *Presence or absence in myxinoids.* Johnston, J. B. 1908.2.

Hypoglossal (XII), *so-called by authors cited; probably, however, in fishes morphologically equivalent to first spinal nerve.* — *Rate of impulse in Bdellostoma.* Carlson, A. J. 1904.2. — *Question of existence in fishes.* Duval, M. 1877.1. — *Relations among various vertebrates.* McMurrich, J. P. 1885.1.

Mesencephalicus nerve. *Found in larval form (Ammocœtes), sparingly in adult Petromyzon. Possibly a member of the transient nervous system* (q. v.). Tretjakoff, D. 1909.1.

Oculomotor (III). *Anatomy and morphology.* Harman, N. B. 1899.1; ★Neal, H. V. 1912.1, Add. **1914.1.** — *Ganoidei.* Schneider, H. 1881.1. — *Ameiurus.* Workman, I. S. 1900.1.

Histology, ganglia of oculomotor nerve. — *Ciliary ganglion.* Beard, J. 1888.1; Ewart, J. C. 1890.2; Onodi, A. D. 1901.1, Add. 1887.1; Schwalbe, G. A. 1879.1. — *Intracranial ganglion, Scyllium.* Nicholls, G. E. 1915.1.

Histology, motor nuclei. Huet, W. G. 1911.1; Kappers, C. U. 1913.1.

Origin and development. Beccari, N. 1909.2; Harman, N. B. 1899.1. — *Elasmobranchii.* ★Gast, R. **1909.1;** Sedgwick, A. 1895.1.

Olfactory (I). (*For peripheral terminations of the first nerve in the organ of smell, see under* Olfactory organs.)

Anatomy. — *Amia.* Brookover, C. 1909.1, 1910.1. — *Ameiurus.* Brookover, C. & Jackson, T. S. 1911.1.

Development. ★Locy, W. A. **1899.1.** — *Nerve and ganglion, Lepidosteus.* Brookover, C. Add. 1914.1.

Physiology. Garten, S. Add. 1903.1. — *Velocity of conduction of impulses, Esox.* Nicolai, G. F. 1901.1, 1905.1. — *Effects of electrical stimulus, Esox.* Sulze, W. 1909.1.

Optic nerve (II) and Chiasma. *For peripheral terminations of the optic nerve see* Retina *under* Eye.

Stages in degeneration of optic nerve after removal of eye. Krause, K. 1898.1.

Anatomy of optic nerve. ★Deyl, J. **1896.2;** Studnička, F. K. 1897.1, 1898.3. — *Acanthopsidæ and Siluridæ.* Deyl, J. 1896.1. — *Teleosts.* Messing, S. V. 1907.1. — *In the blind cave fish, Amblyopsis.* Ramsey, E. E. 1901.1. — *Syngnathus.* Studnička, F. K. 1901.3. — *Xiphias.* Malpighi, M. Pre-Linn. 1686.1.

Place of origin in brain. Bellonci, G. 1880.2, 1888.1; Stein, S. A. Add. 1834.1. — *As part of central nervous system.* Monro, T. K. 1896.1.

Phylogeny. Gaskell, W. H. 1898.1 (ix).

Optic chiasma, structure. Rudolphi, C. A. 1800.1; Soemerring & Noethig, Add. 1791.1.

Optic chiasma in Teleostei. Fusari, R. 1896.1; Parker, G. H. 1901.1, 1903.2. — *Gadus.* Hoeven, J. 1832.1; Mayer, A. F. 1829.1. — *Clupea.* Weber, E. H. 1827.1. — *Engraulis.* Solger, B. F. Add. 1877.1.

Nervous System — *Cont'd.*

Dorsal position of either right or left nerve in the crossing is a matter of chance and not a heritable character as shown in breeding experiments with brook-trout and cod. Larrabee, A. P. 1906.1.

For changes in the optic tract accompanying migration of the eye in flatfishes, see under Pleuronectidæ. *See especially* Mayhoff, H. 1912.1; Williams, S. R. 1902.1.

Terminalis (**Pinkus's nerve**). *A sensory nerve arising from the anterior part of the fore-brain and innervating the epithelium of the nasal sac. Discovered by R. Pinkus in Protopterus in* 1894.

Anatomy. — *Amia and Lepidosteus.* ★Brookover, C. 1908.1, 1909.1, **1910.1.** — *Ameiurus.* Brookover, C. & Jackson, T. S. 1911.1. — *Heptanchus.* Burckhardt, C. R. 1906.3. — *Selachii.* ★Locy, W. A. 1899.1, 1904.1, 1905.2. — *Selachii and Dipnoi.* ★Pinkus, F. 1894.1,.2, 1905.1. — *Teleosts.* Sheldon, R. E. 1909.1; Sheldon, R. E. & Brookover, C. 1909.1; Giacomini, E. Add. 1914.1.

Various researches on N. terminalis. — *Development in Selachii.* Belogolowy, G. 1912.1. — *Physiology, Selachii,* Kschischkowsky, K. 1912.1. — *Ganglion cells, Mustelus.* McKibben, P. S. 1914.1.

Trigeminal or Trifacial (V). *Anatomy.* Friant, A. Add. 1879.1; Valkenberg, C. T. Add. 1911.1. — *Gadus.* Baudelot, E. 1868.9. — *Murænidæ.* Calandruccio, S. 1896.1. — *Lota.* Goronowitsch, N. 1897.2; Toppelius, O. A. Add. 1846.1.

Various morphological papers. — *End-organs in skin, Bdellostoma.* Ayers, H. & Worthington, J. 1907.1. — *Plexus ophthalmicus in Amia and Lepidosteus.* Belogolowy, G. 1912.1. — *Phylogeny of trigeminal.* Gaskell, W. H. 1898.1 (v, vii). — *Spinal ganglia of trigeminal.* Haller, B. 1910.1. — *Trigemino-facialis complex, Gadus and Ameiurus.* Herrick, C. J. 1900.2. — *Mesencephalic root.* Johnston, J. B. 1905.4. — *Parts innervated, Selachii, Ganoidei and Dipnoi.* Luther, A. F. 1909.3, 1913.2. — *Origin, Teleosts.* Orrù, E. 1913.1.

Branches of trigeminal nerve. — *Ganglia of ophthalmicus profundus in Selachii.* Beard, J. 1888.1. — *Mandibularis trigemini, variations, Gadus.* Holmquist, O. 1913.2. — *Ophthalmic branch, Ameiurus.* Workman, I. S. 1900.1. — *Lateralis branch, Lota and Silurus.* Weber, E. H. 1827.9.

For the muscles innervated by the Trigeminal nerve, see Cranial and visceral muscles, *under* Myology.

Trochlearis or Patheticus (IV). *Anatomy and morphology.* Dohrn, F. A. 1882.2 (xxv); ★Fürbringer, M. **1902.1;** Kappers, C. U. 1913.1; ★Neal, H. V. 1912.1, Add. **1914.1.** — *Teleostei.* Beccari, N. 1909.2; Franz, V. 1911.3. — *Ganoidei.* Schneider, H. 1881.1. — *Ameiurus.* Workman, I. S. 1900.1.

Various researches on morphology and development. — *Gadus, dorsal ramus.* Baudelot, E. 1873.2, (*Homologies*). 1868.6. — *Development, Torpedo.* Froriep, A. 1891.1. — *Nuclei of trochlear nerve.* Huet, W. G. 1911.1.

Vagus or Pneumogastric (*X*). *Anatomy and morphology.* Baudelot, E. 1868.3, 1869.1; Hoffmann, C. E. 1860.1; Moreau, F. A. 1859.1; Onodi, A. D. Add. 1887.1; Bruner, G. Add. 1893.1. — *Selachii.* ★Dohrn, F. A. **1882.2** (xix, xxi). — *Cyclostomata.* Ransom, W. B. & Thompson, D. W. 1886.1.

Teleostei. — *Gadus.* Baudelot, E. 1868.9. — *Orthagoriscus.* Sauvage, H. E. 1910.1. — *Anguilla.* Waga, T. 1896.1.

Researches on origin and histology of vagus. — *Teleostei.* ★Haller, B. 1895.1, **1896.1.** — *Selachii.* Rohon, J. V. 1878.1; Shore, T. W. 1889.1.

Physiology. — *Influence of section of nerve on gases of air bladder.* Bohr, C. 1894.1. — *Influence of pneumogastric on heart, sharks.* Cadiat, L. O. 1879.1. — *Rate of impulse, Bdellostoma.* Carlson, A. J. 1904.2. — *General account of physiology of vagus.* Hoffmann, C. E. 1860.1.

Lateralis system of vagus nerve. ★Fée, F. 1866.1, Add. 1869.1. — *Selachian embryos.* Dohrn, F. A. 1882.2 (xix). — *Lota and Silurus.* Weber, E. H. 1827.9.

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Anatomy and morphology. Baudelot, E. 1868.11; Gaskell, W. H. 1888.1; Trinci, G. 1905.1, 1906.1. — *Amphioxus.* Balfour, F. M. 1876.3. — *Elasmobranchii.* Ewart, J. C. & Cole, F. J. 1895.1. — *Chlamydoselachus.* Hawkes, O. A. 1906.1. — *Cyclostomata.* Ransom, W. B. & Thompson, D. W. 1886.1; Schneider, A. F. 1880.2.

Anatomy in Teleostei. — *Teleosts.* Allis, E. P. 1898.2. — *First spinal nerves, Amia and Scomber.* Allis, E. P. 1895.1, 1898.1,.2, 1903.4. — *Scomber.* Dewitz, J. 1904.1. — *Menidia.* ★Herrick, C. J. **1899.1.**

Various anatomical items. — *Distribution, Elasmobranchii.* Bardeen, C. R. 1904.1. — *Ventral ramus, anterior spinal nerves, Selachians.* Braus, H. 1892.1. — *Conceived as a complex of two separate nerves.* Wijhe, J. W. 1897.1.

Development. — *Elasmobranchii.* Balfour, F. M. 1875.2. — *Motor nerves, Selachii.* Dohrn, F. A. 1882.2 (xiv). — *Ventral development.* Neal, H. V. 1900.1, 1903.1. — *General account of development.* Sagemehl, M. 1882.1.

SPINO-OCCIPITAL NERVES

Development, homologies, and morphology. — *Homologies, Amia and teleosts.* Allis, E. P. 1898.1. — *Development, Selachii.* Braus, H. 1899.1. — *Morphology in Holocephali.* ★Fürbringer, M. **1896.1.** — *In Amia.* Ganfini, C. 1912.1. — *In Teleostei.* Supino, F. 1907.3. — *In Ammocœtes.* Wiedersheim, R. E. 1869.1, 1879.1, 1880.1,.3.

SYMPATHETIC NERVOUS SYSTEM

(Nervus sympathicus)

Anatomy and morphology. Froriep, A. 1908.1; ★Jaquet, M. **1900.1**; Marcus, H. 1910.1; Toppelius, O. A. Add. 1846.1. — *Petromyzon.* Julin, C. 1886.1, 1887.7; Ovsyannikov, F. V. 1883.1.

Elasmobranchii. ★Bottazzi, F. **1902.2**; ★Chevrel, R. **1890.1**; Diamare, V. 1902.1; Remak, R. 1837.1.

Teleostomi. — *Teleosts.* ★Chevrel, R. 1888.1, **1890.1**, (*Acipenser*). 1893.1. — *Gadus.* Hjelt, O. E. 1847.1. — *Orthagoriscus.* Sauvage, H. E. 1910.1; Vulpian, E. F. 1865.1.

Development. Froriep, A. 1908.1; ★Ganfini, C. **1912.2**; Kuntz, A. 1911.1; ★Neumayer, L. **1906.1.** — *Elasmobranchii.* Hoffmann, C. K. 1901.1 (*Acanthias*); Sedgwick, A. 1895.1.

Various researches. — *Preoptic sympathetic system in Amia.* Brookover, C. 1909.1, 1910.1. — *Influence on functions of air bladder.* Harting, P. 1865.1. — *Evolution of sympathetic system.* Kuntz, A. 1911.2. — *Histogenesis.* ★Neumayer, L. **1906.1.** — *Lesion in Rhombus.* Pouchet, G. 1875.3.

For segmental structure of Sympathetic nervous system, see Metamerism.

OLFACTORY ORGANS

For the functions of the olfactory organs, *see* Smell.

Development. *For a comprehensive treatise on the development of the olfactory organs, see* ★Peter, K. **1906.1.**

Development in — Cyclostomata (Ammocœtes). Gaskell, W. H. 1898.1; ★Lubosch, W. 1901.1, 1904.2, 1905.1; Pogojeff, L. 1881.1. — *Teleostei.* Gawrilenko, A. 1910.1; Holm, J. F. 1894.1.

Development of olfactory organs in Selachii. ★Berliner, K. 1902.1; Holm, J. F. 1894.2; Sund, O. 1904.1, 1905.1; Wijhe, J. W. 1886.2.

Morphology, *including microscopical structure.*

Miscellaneous and general. Duméril, A. H. 1860.1; Geoffroy-Saint-Hilaire, E. F. 1825.1; ★Marshall, A. M. **1879.2**; Scarpa, A. 1789.1.

Anatomy in various fishes. — *Mustelus.* Asai, T. 1913.1. — *Cyclostomata.* Ballowitz, E. 1904.1; Burne, R. H. 1908.1; Fœttinger, A. 1876.1. — *Teleosts.* Burne, R. H. 1909.1; Dogiel, A. S. 1886.1; Solger, B. F. (*Gasterosteus*) 1893.1. — *Ganoidei.* Dogiel, A. S. 1886.1; Grimm, O. (*Acipenser*). 1872.1; Waldschmidt, J. (*Polypterus*). 1887.1. — *Amphioxus.* Kölliker, R. A. 1843.1.

Histological structure, including nerve terminations in end organs, etc. Aichel, O. 1897.1; ★Blaue, J. 1882.1; Jagodowski, K. P. 1901.1; Kölliker, R. A. 1857.5; Kolmer, W. 1905.1, 1907.1; Madrid Moreno, J. 1887.1, Add. 1887.1, Add. 1888.1; Pereyaslavtzeva, S. 1876.1; Retzius, M. G. 1879.1, 1880.1,.3, 1892.3,.8; Sheldon, R. E. 1908.2.

Olfactory fossæ *or nasal pits, morphology, functions, etc.*

For a general treatise on the morphology and development of the nasal fossæ, see ★Dieulafé, L. 1904.1, Add. **1906.1.**

Communications of nares with pharynx in — Astroscopus. Dahlgren, U. 1908.2. — *Cynoglossus.* Johnstone, J. 1904.3; ★Kyle, H. M. 1900.6.

Position of nares in — Lepidosiren (anterior opening). Huxley, T. 1876.3. — *Ophichthyidæ.* Lütken, C. F. 1851.1.

Nares rudimentary or degenerate in Tetraodon. Wiedersheim, R. E. 1887.1,.2,.4.

Change of water in olfactory pits, Teleostei. Vescovi, P. 1889.1.

" Monorhinie " and " Amphirhinie," hypothesis advocated by von Kupffer attempting derivation of bilateral nostrils of gnathostomes from the single median monorhinal condition of Cyclostomes. Kupffer, C. W. 1894.1; Peter, K. 1906.1; Sund, O. 1905.1.

OTOLITHS

Comprising the " ear stones " as isolated structures, *i. e.* not in association with other parts of the ear.

For the functions of the otoliths, *see under* Hearing and the static sense.

For the determination of the age of fishes through the study of their otoliths, *see under* Age determination.

General accounts, size, shape, structure, etc. Canestrini, R., & Parmigiani, I. 1883.1; Scott, T. 1906.1; ★Shepherd, C. E. 1910.1,.2, 1914.1.

Structure of otoliths in — Pleuronectes. Immermann, F. 1908.1. — *Gadus.* Redfern, P. 1859.1. — *Petromyzon.* Studnička, F. K. 1912.1.

Miscellaneous papers of little value. Buckland, F. T. 1878.2; Geoffroy-Saint Hilaire, E. F. 1824.9,.10; Jackson, P. 1879.1; Anon. 436; Klein, J. T. Pre-Linn. 1740.1.

Otoliths of species of Gadus dredged from depths of polar seas. Jensen, A. S. 1900.2, 1905.2.

Comparative studies of the otoliths of recent fishes for the purpose of the identification of isolated or fossil otoliths. Costa, O. G. 1866.1; Higgins, E. T. 1867.1, 1868.1; Ihering, H. 1891.1,.2; Koken, E. 1891.1, Add. 1891.1.

Fossil otoliths. *Because of their density, these are often the only remains of fishes preserved in fossil-bearing formations.*

Tertiary otoliths of various formations throughout the world. Bassoli, G. G. 1906.1, 1909.1; ★Koken, E. 1884.1–1888.1, Add. **1891.2**; Meyer, O. 1889.1; Neumayer, L. 1913.1; Pantanelli, D. 1904.2; Pascoe, E. H. 1909.1; ★Priem, F. 1906.1, 1911.2, 1912.2, 1913.1, 1914.1; Schubert, R. J. 1902.1, 1905.1, 1906.2,.3, 1907.1, 1912.1,.2.

Cretaceous otoliths of Germany. Stolley, E. 1906.1, – 1913.1.

OVA AND OVUM

Comprising all non-pelagic eggs.

For all papers relating to the care of their eggs by the parent fishes such as Brood-pouch incubation; Oral gestation; Nest-building; etc., *see under* Reproduction. For number of eggs produced, *see* Fecundity, *under* Reproduction.

For all developmental stages of the ovum, beginning with fertilization, *see under* Embryology.

For the handling of eggs in fish-culture, artificial fertilization, shipment to foreign countries, etc., *see under* Pisciculture.

For size of ova *see under* Oral gestation *under* Reproduction. *Eggs incubated in the mouth of the parent are uniformly large.*

Popular general articles on the fish egg. Cunningham, J. T. 1896.1; McIntosh, W. C. 1885.1, 1886.7, 1889.1; Ryder, J. A. 1886.6.

Chemical Composition

Composition of ovum, especially the yolk, in various fishes. Dubuisson, H. 1906.1; Gobley, — 1850.1, 1851.1; Kensington, E. T. 1884.1; Lams, H. 1904.1; Morin, B. 1823.1; Prince, E. E. 1886.2, 1887.2; Retzius, A. J. 1854.1, 1855.1. — *Esox.* Reichert, C. B. 1856.1,.2; Vauquelin, L. N. 1817.1, Add. 1818.1. — *Acanthias.* Zdarek, E. 1904.1.

Physical and chemical changes during maturation. Milroy, T. H. 1898.1.

Protein substances; albumins, globulins, etc., of ovum including its secondary membranes. Alsberg, C. L. & Clark, E. D. 1908.1; Baumhauer, E. 1848.1; Dezani, S. 1908.1; D'yakonov, K. S. 1866.1; Leuchs, J. C. 1862.1; Miyake, K. & Tadokoro, T. 1911.1; Yoshimura, K. 1913.1. — *Klupeovin.* Hugounenq, L. 1904.1. — *Nucleic acid.* Levene, P. A. & Mandel, J. A. 1906.1; Tschernorutzky, H. 1912.1. — *Purin bases.* Linnert, K. 1909.1. — *Percaglobulin.* Mörner, C. T. 1904.1. — *Phosphoglycoproteins; ichthin ichthidin, and ichthulin.* Levene, P. A. 1901.2; ★Valenciennes, A. & Fremy, E. 1854.2; Virchow, R. L. 1853.1.

Egg-cases of sharks; keratin tertiary membranes, constitution. Buchtala, H. 1908.1; Hussakof, L. & Welker, W. H. 1908.1, 1911.1; Krukenberg, C. F. 1885.1; Pregl, F. 1908.1. — *Comparison with egg capsule of snake.* Krukenberg, C. F. Add. 1882.3,.4.

Egg-cases or Horn-like Membranes

Cyclostomata. *Hooked capsules, probably secondary or follicular membranes.*

Bdellostoma. ★Dean, B. **1899.6**; Doflein, F. J. 1899.3; Plate, L. H. 1896.1.

Myxine. Cunningham, J. T. 1887.4,.5, 1897.1; Dean, B. 1900.2, 1903.3, 1904.7; Jensen, A. S. 1900.1; Klinckowström, A. 1895.1; Steenstrup, J. J. 1863.2, 1864.2. — *Development within follicle.* Cunningham, J. T. Add. 1886.1.

Elasmobranchii. *Keratin egg-cases, a tertiary membrane secreted by nidamental gland of oviduct.*

For homologue of the egg-case in viviparous forms, see Fœtal membranes *below* Viviparity *under* Reproduction. *For* Chemical composition, *see above.*

See also Oviposition of shelled eggs of Selachii *and* Oviparity of Elasmobranchii *under* Reproduction.

Manner of formation with structure of nidamental gland, etc. Borcéa, J. 1904.5; Gerbe, Z. 1872.1,.2; Henneguy, L. F. 1893.2; Perravex, E. 1884.1; ★Widakowich, V. 1905.1, 1906.1; Wyman, J. 1859.2,.3. — *Osmotic permeability.* Dakin, W. J. 1911.1,.2; Peyréga, E. 1914.1. — *Orientation in oviduct.* Vaillant, L. L. 1884.1; Widakowich, V. 1908.2.

Batoidei; egg-cases and ova of rays, chiefly Raja. Boldo, B. M. 1797.1; Holt, E. W. 1897.1; Phipson, T. L. 1874.1; Putnam, F. W. 1870.8, 1872.9; Schenk, S. L. 1874.2; Williamson, H. C. 1912.1; Anon. 462. — *Early refs.*, Pre-Linn. *section.* Needham, J. T. 1745.1; Paullini, C. F. 1701.1.

Selachii; eggs and egg-cases of various sharks. Agassiz, J. L. 1873.1; Tilesius von Tilenau, W. 1802.1; Troschel, F. H. 1874.1; Vávra, V. Add. 1901.1. — *Heptanchus.* Braus, H. 1906.4. — *Scyllium.* Couch, J. 1844.3; Portlock, J. E. 1845.1,.2; Thompson, W. 1844.2. — *Ginglymostoma.* Gudger, E. W. 1913.1, Add. 1912.2. — *Stegostoma.* Vaillant, L. L. 1878.1. — *Heterodontus.* ★Waite, E. R. 1896.1.

Two ova in a single egg-case, a teratological condition. Joseph, H. 1906.1; Vayssière, A. 1909.1.

So-called "wind-eggs" (of Elasmobranchii) are also known where the egg-case is formed when no egg is present as in similar cases in birds.

Holocephali. *Egg-capsules of Chimæridæ.* Agassiz, J. L. (*Callorhynchus*) 1873.1; ★Dean, B. 1904.1,.2,.6,.9, **1906.1**, 1912.6; Prince, E. E. 1897.1.

Fossilized remains of egg-cases of Chimæroids. — *Jurassic of Württemberg.* Bessels, E. 1869.1; Jaekel, O. 1896.1, 1901.1. — *of Spain.* Sauvage, H. E. 1905.2. — *of France.* Leriche, M. Add. 1914.1. — *Cretaceous of America.* Dean, B. 1909.5; Gill, T. N. 1905.3.

Egg-membranes of Teleostei

For the most valuable "Historical and critical review of the literature on the primary egg membranes and the micropyle in fishes," *inclusive of all groups, see* ★Mark, E. L. **1890.1**.

General papers. Lanzi, L. 1909.1,.3, 1910.1; ★Mark, E. L. **1890.1**; Müller, J. 1854.1; Ovsyannikov, F. V. 1885.1; Scharff, R. F. 1886.1; ★Eigenmann, C. H. Add. **1890.2**.

Vitelline or primary membrane. Hogg, J. 1855.2; ★Lallinger, J. 1901.1; Stockmann, R. 1883.1.

Follicular or secondary membrane. Retzius, M. G. 1912.1.

Factors governing permeability by sperm. Brown, O. H. 1905.1; Newman, H. H. 1905.1.

Softening of membranes by digestive fer-

ment at time of hatching. Kerr, G. 1900.1; Wintrebert, P. 1912.1,.2.

Micropyle. *Structure, etc.* André, J. 1875.1; Bruch, C. W. 1856.1; Buchholz, R. W. (*Osmerus*) 1863.1; Ransom, W. H. 1855.1, 1867.1; Reichert, C. B. 1856.1; Ryder, J. A. (*Morone*) 1882.5; Siebold, C. T. 1856.1. — *Record of discovery* (*Syngnathus*). Doyère, M. P. 1849.1. — *Multiple micropyles in Acipenser.* Murray, A. 1871.1; Zalenskiĭ, V. V. 1878.1.

Ovarian Ovum

Histological structure. *Including deposition and microscopic structure of yolk.* Auerbach, L. 1891.1; Calderwood, W. L. 1892.1; Comes, S. 1905.2, 1906.1; ★Cunningham, J. T. 1893.1, 1897.3, **1898.1**; Franz, V. 1910.6; His, W. 1873.1; Scharff, R. F. 1888.1; Solger, B. F. 1885.1; ★Wallace, W. 1903.1. — *Dipnoi.* Beddard, F. E. 1887.1,.2,.3. — *Gasterosteus.* Beale, L. S. 1867.1; Ransom, W. H. 1867.3.

Yolk-nucleus or vitelline body. (*Dotterkern, corps vitellin, nucleus of Balbiani, etc.*) Bambeke, C. 1873.1, 1874.1, 1883.1; Franz, V. 1907.5 (*Pleuronectes*); ★Henneguy, L. F. **1893.1**, Add. 1887.1; Hubbard, J. W. 1903.1 (*Cymatogaster*); Kastschenko, N. 1888.2, 1890.1; Stéphan, P. 1901.2, 1902.6; Wallace, W. 1903.1.

Oögenesis and maturation of ovum. *General treatises.* ★Hertwig, R. **1903.1**; Rabl, C. 1915.1; Jörgensen, M. Add. 1913.1.

Oögenesis in Amphioxus. Maréchal, J. 1907.1; Sobotta, J. 1897.2; Stricht, O. 1896.1.

Cyclostomes — Myxine. Cunningham, J. T. 1887.4. — *Petromyzon.* Böhm, A. A. 1888.1; Calberla, E. 1877.1; Herfort, K. V. 1893.1, 1900.1.

Elasmobranchii. Cerruti, A. 1905.1, 1908.1; Kastschenko, N. 1890.1; Ludwig, H. J. 1875.1; Maréchal, J. 1907.1; Maréchal, J. & Saedeleer, A. 1910.1; ★Rückert, J. 1892.1; Schmidt, A. H. 1898.1.

Teleostei. Balbiani, E. J. 1873.1, 1879.1; Fulton, T. W. 1898.1,.2,.3; Kolessnikow, N. 1878.1; ★Maréchal, J. 1904.1–**1907.1**. — *Salmo.* Behrens, G. 1898.1; Blanc, H. 1891.1, 1892.1, 1894.1. — *Lebias.* Mazza, F. 1901.3.

Halving of somatic number of chromosomes during maturation, nature of reduction division, etc. Bambeke, C. 1893.1; Moore, J. E. 1894.1; Nusbaum, J. 1913.1; Rückert, J. 1893.1; Rohde, E. Add. 1911.1.

For the Origin and migration of the germ cells, *see under* Embryology.

Pelagic or Planktonic Ova

Since the literature of this subject cannot be readily disassociated from that relating to larval fishes, it has been placed under Planktonic fauna, *which see.*

Various Teleostean Ova

Special papers with descriptions of eggs of — Osmerus. Cunningham, J. T. 1886.1. —*Anchovy* (*size of egg*). Dietz, P. A. 1908.1. — *Gobius.* Guitel, F. 1892.3; Meek, A. 1903.3; Retzius, M. G. 1911.2. — *Lepadogaster.* Guitel, F. 1887.1. — *Lebias.* Lepori, C. 1881.1. —*Agonus and Blennius.* McIntosh, W. C. 1885.4, 1903.1. —*Atherina.* Pagenstecher, H. A. 1861.1. —*Lota.* Prince, E. E. & Halkett, A. 1906.1; Wesenberg-Lund, C. J. 1909.1. —*Crystallogobius.* Raffaele, F. 1895.2. — *Stizostedion.* Reighard, L. E. 1893.2. — *Menidia.* Ryder, J. A. 1883.2. — *Sparus and Sebastes.* Williamson, H. C. 1911.4.

For fixed ova or eggs arranged and cared for by parents, see Nest-building *under* Reproduction.

Descriptions of pelagic Teleostean ova will be found under Planktonic fauna.

For structure of the eggs of Cyclostomata, *and* Elasmobranchii, *see above under* Egg-cases.

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General Treatises

Text in English. *Zittel's Text-book of Palæontology.* ★Eastman, C. R. **1902.10**; *A Manual of Palæontology, etc.* ★Nicholson, H. A., & Lydekker, R. **1889.1**; *Outlines of vertebrate palæontology, etc.* ★Woodward, A. S. **1898.7**. — *Encyc. arts.:* Marsh, O. C. 1895.1; Osborn, H. F. 1911.1.

Popular treatises: Creatures of other days. Hutchinson, H. N. 1894.1; *Extinct animals,* Lankester, E. R. 1905.1; *The origin and evolution of life,* Osborn, H. F. 1916.1; *The young collector's handbook of fossils,* Woodward, B. B. 1885.1; *Animals of the past,* Lucas, F. Add. 1901.1; *Animals before man in America,* Lucas, F. A. Add. 1902.1; . . . *Introduction to the study of fossil organic remains,* Parkinson, J. Add. 1822.1.

Text in French. *Les enchaînements du monde animal dans les temps géologiques,* Gaudry, J. A. 1883.1, 1890.1; *Traité élémentaire de paléontologie,* Pictet, F. J. 1844.1; *Traité de paléontologie,* Zittel, K. A. 1893.1. — *Encyc. arts.:* Blainville, H. M. D. 1808.2; Sauvage, H. E. Add. 1869.1.

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Text in Russian. Trautschold, H. von. 1875.1.

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Text in Swedish. Sederholm, J. J. 1916.1.

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Special Articles

The relations of the horizons of extinct vertebrata of Europe and North America, Cope, E. D. 1879.5; *First calcareous fossils, etc.,* Daly, R. A. 1910.1; *Ancient fauna compared with present day fishes,* Giebel, C. G. 1848.1; *Recueil des monumens des catastrophes,* Knorr, G. W., & Walch, J. E. 1768.1; *The progress of vertebrate palæontology in Canada,* Lambe, L. M. 1904.1, 1904.2; *The past vertebrate life of Canada,* Lambe, L. M. 1912.2; *Illustrations of antediluvian zoology,* Taylor, R. C. 1830.1; *The imperfection of the geological record,* Woodward, A. S. 1898.2; *Relations of palæontology to biology,* Woodward, A. S. 1906.7; *The study of fossil fishes,* Woodward, A. S. 1906.8; *The use of fossil fishes in stratigraphical geology, Ibid.* 1915.2; *Palæontology and the biogenetic law,* Zittel, K. A. 1895.2.

History. *History of instruction in German universities,* Eastman, C. R. 1894.2; *La géologie antique, etc.,* Schvarcz, G. 1861.1; *History of Scottish fossil ichthyology,* Traquair, R. H. 1880.1; *History to end of 19th century,* Zittel, K. A. 1899.1, 1908.1.

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Text in German. Kayser, F. H. 1913.1; Lepsius, C. G. R. 1887.1, 1903.1.

Collections, Exhibitions, Type-Specimens, etc. For palæontological material in particular collections and institutions, see under Museums.

Early references to fossil fishes, bufonites, glossopetræ (*sharks' teeth*), *etc. in* Pre-Linn. *section.*

Aldrovandi, U. 1648.1; Armstrong, J. 1752.1; Bartholinus, C. 1704.1; Besler, B. 1716.1; Boccone, P. 1670.1; Boodt, A. B. 1609.1; Brückmann, F. E. 1742.1; Buonammi, F. 1709.1; Charleton, G. 1668.1; Columna, F. 1606.1; Evelyn, J. 1668.1; Fischer, C. G. 1714.1; Geyer, J. 1687.1; Gimma, G. 1730.1; Imperato, F. 1628.1; Jussieu, A. 1723.1; Kentman, J. 1565.1; Kircher, A. 1678.1; Knorr, G. W. 1754.1; Koenig, E. 1690.1; Luid, E. 1693.1; Major, D. B. 1704.1; Mylius, G. F. 1709.1; Nuenning, J. H. 1746.1; Petiver, J. 1706.1; Ray, J. 1673.1; Steno, N. 1669.1; Stobæus, J. 1738.1; Swammerdam, J. 1679.1; Torrubia, F. J. 1754.1; Valentini, M. B. 1708.1; Woodward, J. 1728.1; Worm, O. 1686.1.

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France. *Paléontologie de la France.* Archaic, E. J. 1868.1; *Zoologie et paléontologie française, etc.* 2 vols. Gervais, F. L. 1848.2, 1859.2.

Germany. *Index Palæontologicus.* Goeppert, H. R., & Meyer, H. 1848.1; *Petrefacta Germaniæ.* Goldfuss, G. A. 1826.1.

Italy. *Bibliografia mineralogica geologica e palæontologica della Toscana.* Achiardi, A. d'. 1875.1; *Enumération des poissons fossiles d'Italie.* Agassiz, J. L. R. 1840.1; *Ittiologia fossile Italiana.* Costa, O. G. 1855.2, 1857.2.

Stratigraphical Arrangement of the Fossil Fish-Fauna of the World, with emphasis on particular localities where fish-bearing strata are exposed.

In general, statements of the authors are taken as authority for references to the particular periods. Where conflicts in opinion occur, the weight of evidence is considered to be in favor of the later paper and the references are so arranged.

In some cases, this arrangement becomes necessarily empirical. The age or period will generally be found in accord with Woodward, A. S., " Catalogue of . . . British Museum" (1889.2) and Hay, O. P., "Bibliog. and Cat." (1902.1), when the papers are comprised in these works.

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The Palæozoic fishes of North America. ★Newberry, J. S. **1889.1.** — *Reviews of this work:* Cope, E. D. 1890.2; Jaekel, O. 1893.1; *American Palæozoic fossils, catalogue of genera and species.* Miller, S. A. 1877.1; *Classification of Palæozoic fishes.* Rohon, J. V. 1896.1; *Lists of Palæozoic fishes:* (British) Barkas, W. J. 1874.3; Etheridge, R. 1881.1; *Adaptive radiations.* Abel, O. 1907.1.

ORDOVICIAN (Lower Silurian)

North America

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Europe

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Oceanica

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Systematic arrangement of Devonian fishes. Huxley, T. H. 1861.3.

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Canada: *Manitoba.* Whiteaves, J. F. 1892.1.—*New Brunswick, Campbellton.* Traquair, R. H. 1890.2, 1893.2; Whiteaves, J. F. 1881.2, 1887.1; Woodward, A. S. 1892.8.—*Nova Scotia, Knoydart formation.* Ami, H. M. 1901.1.—*Ontario* (*Prov.*) Lennox, T. H. 1886.1; Whiteaves, J. F. 1898.2.—*Quebec* (*Prov.*), *Baie des Chaleurs.* Cope, E. D. 1881.2; Whiteaves, J. F. 1880.1.; *Gaspé.* Lankester, E. R. 1870.2,.4; Dawson, J. W. Add. 1858.1; *Scaumenac Bay.* Hussakof, L. 1912.4; Traquair, R. H. 1890.2, 1893.2; Whiteaves, J. F. 1881.3, 1882.1, 1887.1, 1907.2; Woodward, A. S. 1892.6, 1900.6.

Greenland: Woodward, A. S. 1901.1.

United States: **Colorado.** Cockerell, T. 1913.2; Eastman, C. R. 1904.9, 1915.2; Hay, O. P. 1900.1, 1902.2. **Illinois.** Eastman, C. 1899.1; Hay, O. P. 1900.1; Udden, J. A. 1897.1, 1899.1; Weller, S. 1899.1. **Indiana.** Norwood, J. & Owen; D. 1846.1,.2. **Iowa.** Arey, M. F. 1906.1, ★Eastman, C. R. 1897.4, 1903.3, (*General treatise*) **1908.1**; Lindahl, J. 1897.1. **Maryland.** Swartz, C. K. 1913.1. **Missouri.** Branson, E. B. 1914.1; Weller, S. 1906.1. **New York.** Bradley, F. H. 1866.1; Clarke, J. M. 1885.1, 1893.1, 1903.1; ★Eastman, C. R. 1899.5, (*General treatise*) **1907.1**; Hinde, G. J. 1879.3; Kindle, E. M. 1896.1; Newberry, J. S. 1884.1; Ringueberg, E. N. 1884.1; Smith, B. 1909.2, 1910.1; Van Ingen, G., & Clark, E. 1903.1; Williams, H. S. 1882.1; Williams, H. U. 1886.1; Butts, C. Add. 1903.1. **Ohio.** Brainerd, J. 1852.1; Branson, E. B. 1908.2–1911.1; Claypole, E. W. 1888.1–1903.1; Dean, B. 1893.2, 1898.1, 1901.4, 1911.1; Hallock, C. 1873.4; Hitchcock, C. H. 1868.1,.2; Hussakof, L. 1905.1–1911.1; ★Newberry, J. S. 1857.1,.3, 1868.2, 1870.1, 1873.1, 1874.1, 1883.2,.3, 1885.1,.2, 1887.2, **1889.1**; Stauffer, C. R. 1909.1. **Pennsylvania.** Claypole, E. W. 1883.1,.2, 1884.2; Cope, E. D. 1892.5; Hay, O. P. 1900.1; Leidy, J. 1858.1; Lesley, J. P. 1889.1; Hall, J. Add. 1843.1. **Wisconsin.** Cleland, H. F. 1911.1; Eastman, C. R. 1899.2; Lapham, I. A. 1859.1; Newberry, J. S. 1877.1; Teller, E. E. 1911.1.

South America

Brazil: *Amazonas, Rio Maecurú.* Katzer, F. 1897.1.

Asia

Siberia: *Yeniseisk* (*Govt.*) (*Jenissei*). Rohon, J. V. 1889.2, 1890.2.

Europe

Austria-Hungary: *Bohemia.* Barrande, J. 1872.1,.2; Koenen, A. 1895.1; *Settenz near Teplitz.* Raffelt, R. 1877.1; *Lower Austria, Hütteldorf.* Redlich, K. A. 1896.1.

Belgium: Beneden, P. J. 1869.2, 1870.2; Beneden, P., & Koninck, L. 1864.1; Cope, E. D. 1892.1; Dollo, L. 1913.1; Dormal, V. 1887.1; Firket, A. 1874.1; Fourmarier, P. 1899.1; Fraipont, C. 1908.1, 1912.1; Koninck, L. 1878.1; Leriche, M. 1912.3 (*Dour*); Lohest, M. 1881.1–1890.1; Maillieux, E. 1909.1; Malaise, C. 1887.1 (*Namur*); Stainier, X. 1894.1.

British Is.: *Old Red Sandstone.*—*Monographs.* ★Agassiz, J. **1844.3**; ★Powrie, J., & Lankester, E. **1868.1**; ★Traquair, R. H. **1894.2, 1904.1, 1906.1**.—*Popular treatises.* Bigsby, J. J. 1878.1; Lankester, E. R. 1864.1; Miller, H. 1841.1, 1859.1; Etheridge, R. Add. 1888.1 (*List*). **England: Cornwall** (*Co.*). Fox, H. 1900.1; Lankester, E. R. 1868.1; Peach, C. W. 1846.1, 1868.1; Pengelly, W. 1849.1–1868.1; Symonds, W. S. 1868.1, 1872.1; Woodward, A. S. 1901.2 (*Looe*); Woodward, H. 1868.1; Wyatt-Edgell, E. 1868.1. **Devon** (*Co.*). Hamling, J. G. 1908.1; Lankester, E. R. 1868.1; Pengelly, W. 1849.1–1868.1; Symonds, W. S. 1868.1; Woodward, H. 1868.1; Wyatt-Edgell, E. 1868.1. **Durham** (*Co.*). Hut-

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ton, W. 1831.1. **Hereford** (*Co.*), *Old Red Sandstone.* Lankester, E. R. 1861.1,.2; Symonds, W. S. 1859.1; Woodward, A. S. 1888.7 (*Ledbury*). **Nottingham** (*Co.*), *Mansfield.* Sweet, G. 1890.1. **Salop** (*Co.*), *Farlow.* Egerton, P. 1862.1. **Somerset** (*Co.*), *Portishead.* (*Old Red Sandstone.*) Baily, W. H. 1864.1; Gardiner, E. 1892.1; Williams, D. 1842.1. **Orkney Is.** (*Old Red Sandstone*). Flett, J. S. 1898.1; Traill, T. S. 1841.1, 1845.1. **Scotland.** (*Old Red Sandstone.*) Agassiz, J. 1834.4, 1839.2, 1842.2, 1843.1, 1846.3; Ibbetson, G. A. 1867.1; M'Coy, F. 1848.2; Malcolmson, J. G. 1838.1, 1842.1; Murchison, R. I. 1839.1; O'Connell, M. 1916.1; Pander, C. H. 1857.1, 1858.1, 1860.1; Pengelly, W. 1862.1; Roberts, G. E. 1852.1; Traquair, R. H. 1901.3 (*List*).—*Argyll* (*Co.*), *Oban.* Traquair, R. H. 1899.1.—*Berwick* (*Co.*), *Earlston.* Goodchild, J. G. 1905.1. —*Caithness* (*Co.*), *Achanarras quarry.* Peach, C. W. 1859.1, 1867.1; Traquair, R. H. 1890.7, 1892.1, 1893.6, 1894.1,.5; Sedgwick, A., & Murchison, R. Add. 1835.1.—*Cromarty* (*Co.*). Miller, H. 1842.1.—*Edinburgh* (*Co.*). Jameson, R. 1837.1.—*Elgin* (*Co.*). Owen, R. 1841.2; Roberts, G. E. 1864.1.—*Fife* (*Co.*), *Dura Den.* Anderson, J. 1837.1; Anderson, John 1859.1, 1860.1, Add. 1859.1; Mitchell, H. 1863.2; Traquair, R. H. 1892.3; Walker, R. 1863.1; Woodward, A. S. 1915.1.—*Forfar* (*Co.*). Mitchell, H. 1885.1; Newton, E. T. 1892.1; Powrie, J. 1860.1–1870.1; Traquair, R. H. 1899.2.—*Moray* (*Co.*). Taylor, W. 1908.1; Traquair, R. H. 1894.6, 1896.2, 1897.1, 1904.3.—*Roxburgh* (*Co.*), *Melrose.* Peach, C. W. 1874.1. **Shetland Is.** Traquair, R. H. 1908.1.—**Wales,** *Breconshire, Hay.* Symonds, W. S. 1871.1.

France: *Mayenne* (*Dept.*). Bézier, T. 1913.1.—*Pas-de-Calais* (*Dept.*). Barrois, C. 1874.1, 1875.1; Dorlodot, H. 1912.1,.2; Gosselet, J. A. 1903.1; Leriche, M. 1903.1,.2, 1906.1, Add. 1912.1.—*Saône-et-Loire* (*Dept.*). Landriot, — 1849.1, 1850.1.

Germany: *Prussia: Hesse-Nassau, Bicken near Herborn.* Koenen, A. 1888.1, 1895.1.—*Rhine Prov., Eifel chalk.* Agassiz, J. L. 1846.6; Eastman, C. R. 1900.6, 1901.1; Huene, F. 1900.1,.2; Jaekel, O. 1899.1; Meyer, C. E. 1851.3, 1855.1, 1859.1; Roemer, C. F. 1856.1; Holzapfel, E. Add. 1910.1; *Gerolstein.* Beyrich, H. E. 1877.1; Kayser, F. H. 1880.1; Koenen, A. Add. 1886.1; Lee, J. E. Add. 1882.1; *Gemünden.* ★Traquair, R. H. 1896.4, 1902.4, **1903.2, 1905.3.**—*Silesia* (*Prov.*). Kade, G. 1858.1.—*Waldeck* (*Princip.*), *Wildungen.* Jaekel, O. 1903.5, 1904.1, 1906.3, 1907.1; Koenen, A. 1883.1. —*Westphalia.* Schlüter, C. 1867.1, 1888.1. —*West Prussia, Dantzig.* Klein, J. T. 1770.1.—*Harz Mts.* Kayser, F. H. Add. 1878.1.

Russia: ★Agassiz, J. L. **1844.3,** Add. 1845.1; Pander, C. H. 1857.1, 1858.1, 1860.1; Rohon, J. V. 1889.1, 1900.1.—*Archangel* (*Govt.*), *Petchora* (*Dist.*). Keyserling, A. Add. 1846.1.—*Livonia.* Asmuss, H. 1839.1; Doss, C. B. 1898.1; Grewingk, C. C. 1861.1; Kutorga, S. S. 1835.1. —*Novgorod* (*Govt.*). Eichwald, C. E. Add. 1840.1.—*Orel* (*Govt.*). Fischer von Waldheim, G. 1852.1.—*Voronezh* (*Govt.*), *Slawänka near Pavlovsk.* Eichwald, C. E. 1844.1–1853.1.—*Tula* (*Govt.*). Trautschold, H. 1874.1, 1876.1.

Spitzbergen: Lankester, E. R. 1884.1; Woodward, A. S. 1891.2, 1900.4, Add. 1889.2.

Oceanica

Australia: *New South Wales.* Etheridge, R. 1906.1.

CARBONIFEROUS

Animals of the Coal Measures. Miall, L. C. 1878.4.

Africa

Madagascar I.: Woodward, A. S. 1910.4. **Natal;** *Ecca shales.* Hatch, F. H. 1910.1; Woodward, A. S. 1910.1. *Somkele.* Woodward, A. S. Add. 1907.1. **Nyasaland.** Traquair, R. H. 1910.1.

North America

Canada: *New Brunswick: Albert coal mine in Hillsborough.* Dawson, J. W. 1866.1, 1877.1, 1878.1; Egerton, P. 1853.1; Jackson, C. T. 1851.1–1854.2; Lambe, L. M. 1909.2, 1910.1.—*Nova Scotia.* Dawson, J. W. 1866.1, 1878.1; Whiteaves, J. F. 1881.1, 1898.1; (*Joggins mines.*) Bell, W. A. Add. 1913.1.

United States: **Alabama.** Tuomey, M. 1858.1. **Idaho.** *Montpelier.* Hay, O. P. 1907.2. **Illinois.** Branson, E. B. 1905.1; Cope, E. D. 1897.2; Eastman, C. R. 1902.1,.2,.7, (*Mazon creek, list*) 1903.1; Hay, O. P. 1895.1; Hitchcock, E. H. 1855.2; Leidy, J. 1860.2; Newberry, J. S. 1868.1, 1887.1, 1888.2,.4; Newberry, J. S., & Worthen, A. 1866.1, 1870.1; St. John, O., & Worthen, A. 1875.1, 1883.1; Worthen, A. H. 1856.1. **Indiana.** Branson, E. B. 1905.1, 1906.1; Eastman, C. R. 1903.1; Hitchcock, E. H. 1855.1, 1856.1; Kindle, E. M. 1898.1 (*List*); Newberry, J. S. 1879.1, 1884.2. **Iowa.** Branson, E. B. 1905.1; Eastman, C. R. 1908.2; Hay, O. P. 1912.1; Keyes, C. R. 1888.1, 1891.1; Savage, T. E. 1903.1. **Kansas.** Beede, J., & Rogers, A. 1906.1; Eastman, C. R. 1902.9; Leidy, J. 1860.7; Moodie, R. L. 1915.2; Twenhofel, W., & Dunbar, 1914.1; Williston, S. W. 1899.2. **Kentucky.** Newberry, J. S. 1868.1. **Missouri.** Eastman, C. R. 1902.9, 1903.1; Leidy, J. 1860.2; *Catalogues.* Hambach, G. 1890.1; Keyes, C. R. 1894.1. **Nebraska.** Eastman, C. R. 1902.9; St. John, O. H. 1870.1, 1872.1. **Nevada.** Dean, B. 1897.3. **New Mexico.** Newberry, J. S. 1876.1; Williston, S., & Case, E. 1912.1. **Ohio.** *Linton coal measures of Jefferson Co.* Cope, E. D. 1873.2, 1874.1, 1897.2; Newberry, J. S. 1853.1,.2, 1856.1, 1868.1, 1873.4, 1874.2. **Oklahoma.** Snider, L. C. 1915.1. **Pennsyl-**

vania. Cope, E. D. 1886.1, 1897.2; Lea, I. 1853.1; Leidy, J. 1858.1; Lesley, J. P. 1889.1. **Texas.** Udden, J., & Phillips, D. 1912.1. **Virginia.** Egerton, P. 1847.1.

South America

Argentina: Tornquist, A. 1904.1.

Asia

India: *Punjab (Prov.), Productus limestone of Salt Range.* Koken, E. 1901.1; Koninck, L. G. Add. 1863.1; Waagen, W. Add. 1880.1.

Europe

Belgium: Boulenger, G. A. 1899.1, 1902.20 (*Denée*); Cornet, J. 1906.1; Destinez, P. 1897.1, 1902.1; Dewalque, G. 1877.1, 1878.1; Fraipont, J. J. 1889.1; Koninck, L. 1842.1; Stainier, X. 1905.1.

British Is.: *General treatise.* ★Davis, J. W. **1883.1.**—*Misc. and Gen.* Bigsby, J. J. 1878.1; Davis, J. W. 1893.1, 1894.1; Hind, W. 1902.1; Hind, W., & Howe, J. 1901.1; Hind, W., & Stobbs, J. 1906.1; *List.* Etheridge, R. Add. 1888.1. **England: Chester** (*Co.*). Ward, J. 1906.1; Ward, J., & Stobbs, J. 1906.1; Wedd, C. B. 1906.1. **Cornwall** (*Co.*), *Polperro.* M'Coy, F. Add. 1851.1. **Derby** (*Co.*). Davis, J. W. 1886.1; Fox-Strangways, C. 1905.1; Jackson, J. W. 1908.1; M'Coy, F. 1848.1; Wilson, E. 1880.1. **Durham** (*Co.*). Kirkby, J. W. 1864.1; Kirkby, J., & Atthey, T. 1864.1. **Gloucester** (*Co.*), *Bristol coalfield.* Bolton, H. 1907.2, 1911.1; Heath, A., & Morgan, C. 1893.1; Reynolds, S. H. 1908.1. **Lancaster** (*Co.*), *Lancashire coal measures.* Binney, E. W. 1840.1; Bolton, H. 1895.1–1907.1, Add. 1890.1, 1905.1; Davis, J. W. 1891.1; Parker, W. A. 1904.1, 1908.1; Sherlock, R. L. 1915.1; Williamson, W. C. 1837.1–1842.1. **Northumberland** (*Co.*), *chiefly Newsham colliery near Newcastle-upon-Tyne.* Atthey, T. 1867.1–1875.1; Barkas, T. 1868.1–1881.1, *General treat.* 1873.1; Barkas, W. 1874.4; Hancock, A., & Atthey, T. 1868.1–1872.1; Howse, R. 1890.2; Kirkby, J., & Atthey, T. 1864.1; Owen, R. 1867.1,.2; Stock, T. 1880.2. **Salop** (*Co.*), *or Shropshire.* Morris, J., & Roberts, G. 1862.1, 1864.1. **Stafford** (*Co.*). Egerton, P. 1835.1, 1866.1; Newton, E. T. 1904.1; Stobbs, J. T. 1905.1; Traquair, R. H. 1874.1; Ward, J. 1870.1, 1904.1, 1905.1. **York** (*Co.*), "*Millstone Grit.*" Aitken, J. 1874.1–1876.2; Davis, J. W. 1871.1–1880.3, 1882.1, 1884.3,.5, Add. 1879.1, 1890.1; Miall, L. C. 1872.1, 1879.1; Painter, W. H. 1873.1, 1874.1; Wellburn, E. D. 1898.1–1907.1; Williamson, W. C. 1842.1; Wilson, G. V. 1910.1; Woodward, A. S. 1900.7, 1916.2; Drake, H., & Sheppard, T. Add. 1910.1; Miall, L. C. Add. 1884.1. **Ireland:** *Armagh Limestone and Cultra, Co. Down.* Davis, J. W. 1882.2, 1890.1; M'Coy, F. 1848.1.—*Fermanagh* (*Co.*). Portlock, J. E. Add. 1843.1.—*Kilkenny* (*Co.*). Bolton, H. 1895.3; Traquair, R. H. 1893.4; Baily, W. H. Add. 1878.1. **Scotland:** Agassiz, L. J. 1834.4; Hinde, G. J. 1900.1; Peach, B., & Horne, J. 1904.1, 1905.1; Smith, John, 1900.1; *Catalogue.* Armstrong, J. Add. 1871.1.—*Clackmannan* (*Co.*). Fleming, J. 1835.1.—*Dumfries* (*Co.*), *Eskdale.* Traquair, R. H. 1881.4, 1884.1,.2.—*Edinburgh* (*Co.*). Conybeare, W. D. 1834.1; Hibbert, S. 1834.1, 1845.1; Kinnear, W., & Anderson, W. 1883.1; Somervail, A. 1872.1; Traquair, R. H. 1875.1, 1877.2, 1879.2, 1903.3; *Blackband ironstone of Borough Lee.* Traquair, R. H. 1881.1,.2, 1882.2, 1883.1, 1884.4, 1890.3.—*Fife* (*Co.*). Binney, E., & Kirkby, J. 1882.1; Horner, L. 1845.1; Kirkby, J. W. 1888.1, 1905.1; Traquair, R. H. (*List*) 1890.1, (*Abden bone bed.*) 1886.3, 1897.3, 1901.4, 1905.1.—*Haddington* (*Co.*), *Gullane.* Traquair, R. H. 1907.2.—*Lanark* (*Co.*). M'Coy, F. 1848.1; Thomson, J. 1867.1, 1874.2; Traquair, R. H. 1874.2, 1885.1; Young, J. 1867.2, 1870.1; Armour, A. Add. 1867.1; Owen, R. Add. 1853.1.—*Linlithgow* (*Co.*). Traquair, R. H. 1879.2. **Wales:** Salter, J. W. Add. 1861.1.

France: *Ain* (*Dept.*). Sauvage, H. E. 1893.3.—*Allier* (*Dept.*), *Buxière-les-Mines.* Sauvage, H. E. 1875.3.—*Nord* (*Dept.*). Barrois, C. 1910.1; Leriche, M. 1908.5.—*Saône-et-Loire* (*Dept.*). Sauvage, H. E. 1891.5.

Germany: *Baden* (*Grand-D.*), *Lenzkirch.* Gerhardt, K. 1899.1.—*Prussia, Saxony* (*Prov.*), *Magdeburg.* Wolterstorff, W. G. 1899.1; *Wettin.* Giebel, C. G. 1847.1, 1868.1; Germar, E. F. Add. 1844.1.—*Silesia* (*Prov.*), *Volpersdorf.* Roemer, C. F. 1865.1.—*Westphalia* (*Prov.*), *Bochum.* Jaekel, O. Add. 1890.2.

Russia: *Kolomna.* Missuna, A. 1907.1.—*Mjatschkowa.* Trautschold, H. 1874.2, 1876.1.—*Moscow* (*Govt.*), *Niatchkovo.* Bogoli͡ubov, N. N. Add. 1914.2.—*Tula* (*Govt.*). Romanovskii, G. D. 1864.1, 1866.1.—*Volga gorge.* Shtukenbergh, A. A. 1905.1.

Oceanica

Australia: *Gascoyne.* Woodward, H. 1886.1.—*New South Wales.* Egerton, P. 1864.1; Woodward, A. S. 1908.1; Koninck, L. G. Add. 1876.1, 1898.1.—*Victoria.* Chapman, F. R. 1912.1; Woodward, A. S. 1902.4, 1903.5, 1906.1.

PERMIAN

Africa

General. Hennig, E. 1913.2.—*Cape Colony, Calvinia* (*Dist.*). Broom, R. 1913.1.—*Madagascar.* Woodward, A. S. 1910.4.

North America

United States: *Catalogues.* Cope, E. D. 1881.1, 1890.3; *General treatise.* ★Hussakof, L. **1911.2.**—*Illinois.* Case, E. C. 1900.1, 1908.1, 1911.1; Cope, E. D. 1875.4, 1877.2,.8, 1884.5,.7.—*Kansas.* Eastman, C. R. 1902.9; Martin, H. T. 1913.1; Williston, S. W. 1897.1.—*Missouri.* Eastman, C. R. 1902.9.—*Nebraska.* Cope, E. D. 1891.3; Eastman, C. R. 1902.9; Knight, W. C. 1899.1.—*New Mexico.* Williston, S., & Case, E. 1912.1.—*Texas.* Cope, E. D. 1880.3, 1883.2, 1884.5,.7, 1891.3, 1895.1; Neumayer, L. 1904.2.

Palæontology — *Cont'd.*

Asia

India: *Kashmir, Khunmu.* Woodward, A. S. 1905.2.

Europe

Austria-Hungary: *Bohemia, "Gaskohle."* ★Fritsch, A. J. 1874.2, 1875.1, 1877.3, 1895.1, 1897.1, (*Gen. treat.*) **1883.1**; *Reviews of this work.* Cope, E. D. 1893.1; Traquair, R. H. 1893.7; Woodward, A. S. Add. 1889.3; *Braunau, Hohenelbe, Winterberg,* etc. Geinitz, H. B. 1860.1; Murchison, R. I. 1863.1; Stur, D. 1873.1; Troschel, F. H. 1851.2.

British Is.: **England,** *Durham* (*Co.*), *"Marl slate."—Catalogue.* Howse, R. 1850.1; *Monograph.* King, W. 1850.1; *List.* Etheridge, R. Add. 1888.1; *Various papers.* Brown, J. C. 1905.1; Hancock, A. 1848.1; Hancock, A., & Howse, R. 1870.1, .2; Howse, R. 1869.1, 1880.1; Kirkby J. W. 1862.1, 1863.1, 1867.1; Sedgwick, A. 1826.1, Add. 1835.1; Traquair, R. H. 1895.1.—*Warwick* (*Co.*), *Hamstead.* Hardaker, W. H. 1913.1.

France: *General.* Sauvage, H. E. 1893.2.—*Allier* (*Dept.*), *"Terrain houiller de Commentry."* Brongniart, C. 1888.1,.2; Fayol, H. 1888.1; Sauvage, H. E. 1888.3, 1889.1, 1892.1; Massal, E. Add. 1894.1. —*Hérault* (*Dept.*), *Lodève.* Sauvage, H. E. 1875.3.—*Saône-et-Loire* (*Dept.*), *Autun.* Gaudry, J. A. 1888.1, Add. 1867.1; Roche, A. 1900.1; Sauvage, H. E. 1891.5, 1893.4.

Germany: Beyrich, H. E. 1848.1; Fischer, C. E. 1856.1.—*Hesse* (*Grand D.*), *Riechelsdorf.* Münster, G. 1841.3, Add. 1842.2; Germar, E. F. Add. 1842.1.—*Prussia: Rhine Province, Lebach near Saarbrücken.* Bronn, H. G. 1829.1; Kner, R. 1868.1; Troschel, F. H. 1857.1; Weiss, E. 1864.1; Goldenberg, C. F. Add. 1873.1; Goldfuss, A. Add. 1847.1; Jordan, A. Add. 1849.1.—*Saxony* (*Prov.*), *Mansfeld.* Germar, E. F. 1824.1, Add. 1825.1; Giebel, C. G. 1856.1, 1857.1; Kurtze, G. A. Add. 1839.1; *Eisleben.* Münster, G. Add. 1842.2.—*Silesia* (*Prov.*), *Klein-Neudorf.* Roemer, C. F. 1855.1, 1857.1.—*Saxe-Coburg-Gotha, Friedrichroda.* Pohlig, H. 1892.1.—*Saxe-Weimar, Gera near Neustadt.* Geinitz, H. B. 1860.1; *Ilmenau.* Fritsch, K. Add. 1860.1.—*Saxony* (*Kingdom*), *Weissig near Pillnitz.* Geinitz, E. Add. 1875.1.

Russia: *Perm* (*Govt.*). Krotov, B. 1904.1; Meyer, C. E. 1860.1; *Krasnoufimsk.* Fredérichs, G. Add. 1911.1.

Oceanica

Australia: *New South Wales.* Woodward, A. S. 1908.1.

MESOZOIC (ERA)

TRIASSIC

Africa

General: Hennig, E. 1913.2.—*Belgian Congo, Lualaba.* Leriche, M. 1910.5, 1911.2.—*Orange Free State, Karroo beds.* Broom, R. 1905.1–1909.2; Woodward, A. S. 1888.14, 1889.7, 1893.3.

North America

Canada: *Alberta, Banff.* Lambe, L. M. 1913.2, 1914.1, 1916.1.—*British Columbia.* Whiteaves, J. F. 1889.1.

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Burma: *Pegu beds.* Pascoe, E. H. 1909.1; Stuart, M. 1910.1; Noetling, F. Add. 1901.1.

Persia: Priem, F. 1908.3.

Europe

Austria-Hungary: *Bohemia.* Meyer, C. E. H. 1848.2; Procházka, V. J. 1900.1, .2; Reuss, A. E., & Meyer, H. 1851.1; Schubert, R. J. 1902.1–1912.2; *Giesshübl.* Toula, F. 1907.1.—*Croatia, Podsused.* Kner, R. 1863.3; *Radoboj.* Steindachner, F. 1859.1.—*Galicia (Prov.), Lemberg.* Lomnicki, A. M. 1897.1; *Wieliczka.* Reuss, A. E. 1866.1.—*Hungary, Budapest.* Vadász, M. E. 1906.1; *Nógrád (Comitat).* Koch, A. 1904.3.—*Istria, Fohnsdorf.* Dreger, J. 1902.1.—*Lower Austria, Vienna Basin. (Wiener Becken)* Dunker, W. 1846.1; Münster, G. 1842.1; Schaffer, F. X. 1913.1,.2; Schubert, R. J. 1902.1–1912.2; *Hernals near Vienna.* Steindachner, F. 1859.1, 1863.6, 1864.2; *Ingersdorf near Vienna.* Fuchs, T. 1871.1; *Leithakalk of Margarethen, Vienna.* Heckel, J. J. 1855.1; Heckel, J. J., & Kner, R. 1861.1; Kner, R. 1862.1.—*Styria, Gairach.* Heckel, J. J. 1851.2.

France: *Alpes-Maritimes (Dept.), Vence.* Priem, F. 1911.2.—*Aude (Dept.), Armisan near Narbonne.* Gervais, F. L. Add. 1862.1.—*Basses-Alpes (Dept.), Céreste.* Sauvage, H. E. 1880.5.—*Côtes-du-Nord (Dept.).* Leriche, M. 1907.1.—*Drôme (Dept.), Eurre.* Fontannes, C. F. 1885.1; Sauvage, H. E. 1881.1.—*Gironde (Dept.), Léognan, Saucats,* etc. Delfortrie, E. 1871.1, 1876.2, Add. 1873.1; Gervais, F. L. 1863.1; Pédroni, P. M. 1844.1; Priem, F. 1911.2, 1914.1,.3.—*Hérault (Dept.), Castries.* Leriche, M. 1907.3.—*Ille-et-Vilaine (Dept.).* Bassani, F. 1879.1; Couffon, O. 1904.2; Leriche, M. 1907.1; Rouault, M. 1858.1; Sauvage, H. E. 1875.3.—*Loire-Inférieure (Dept.).* Priem, F. 1911.2.—*Maine-et-Loire (Dept.).* Couffon, O. 1904.2, 1905.1; Leriche, M. 1907.1. —*Puy-de-Dôme (Dept.).* Sauvage, H. E. 1873.4; Giraud, J. Add. 1902.1; Lecoq, H. Add. 1867.1.—*Rhône (Dept.).* Locard, A. 1878.1.—*Vaucluse (Dept.).* Joleaud, A. 1910.1; Joleaud, L. 1905.1,.2.

Germany: *Alsace, Haguineau.* Couffon, O. 1904.1.—*Baden (Grand Duchy), Oeningen near Constance.* Agassiz, J. L. 1832.2; Münster, G. 1834.1; Winkler, T. C. 1861.1; Woodward, A. S. 1898.6. —*Prussia: Hannover (Prov.), Hassendorf in Stade.* Jordan, A. 1901.1; *Hesse-Nassau (Prov.), Wilhelmshöhe.* Philippi, R. A. 1846.1; *Luneburg District.* Wollemann, A. 1906.1; Reiske, J. Pre-Linn. 1684.1; *Silesia (Prov.), Oppeln.* Andreae, A. 1904.1.—*Württemberg (Kingdom), Baltringen.* Bassani, F. 1880.1; Probst, J. 1874.1–1886.1; Jaekel, O. Add. 1890.4; *Steinheim.* Plieninger, W. H. 1847.1; Fraas, O. Add. 1870.1; *Unter-Kirchberg near Ulm.* Meyer, C. E. H. 1848.1, 1852.1, 1858.1.

Greece: *Euboea I.* Fischer von Waldheim, G. 1838.1, 1850.1; Valenciennes, A. Add. 1861.1.

Italy: *Alessandria (Prov.), Acqui.* Alessandri, G. 1901.1, Add. 1900.1; *Rosignano.* Alessandri, G. 1897.1; Bassani, F. 1914.1.—*Ancona (Prov.), Senigallia.* Ricci, P. 1828.1; *Fabriano.* Canavari, I. Add. 1910.1.—*Aquila (Prov.).* Lupi, A. 1904.1; Nelli, B. 1900.1.—*Belluno (Prov.).* Dal, G. 1908.1.—*Bologna (Prov.).* Bortolotti, E. 1898.1; Vinassa de Regny, P. E. 1899.1, 1902.1.—*Cuneo (Prov.), Alba.* Alessandri, G. 1896.1.—*Emilia (Prov.).* Bassoli, G. G. 1906.1–1907.1; Schubert, R. J. 1906.1.—*Forlì (Prov.), Mondaino.* Bonomi, I. 1896.1.—*Lecce (Prov.), "Pietra Leccese."* Bassani, F. 1903.1, 1914.1; Botti, U. 1879.1; Add. 1868.1; Vigliarolo, G. 1891.1; Capellini, G. Add. 1878.1; Costa, O. G. Add. 1857.1, 1858.1; Guiscardi, G. Add. 1873.1.—*Reggio (Prov.).* Seguenza, L. 1901.1; *Cutrò.* Bosniaski, S. 1879.2; *Capo dell' Armi.* Stefano, G. 1910.2.—*Reggio nell' Emilia (Prov.), Montegazzo.* Ferretti, A. 1879.1,.2; *Note on this work.* Bassani, F. 1881.4.—*Rome (Prov.), Castro dei Volsci.* Bassani, F. 1909.1.—*Tremiti Is.* Bassani, F. 1907.1. —*Turin (Prov.), "Colline de Turin."* Cocchi, I. 1864.1; Sismonda, E. 1846.1–1861.1; Michelotti, J. Add. 1861.1.—*Tuscan Archip., Isola Pianosa.* Chelussi, I. 1906.1; Costa, O. G. 1863.1.—*Tuscany, Gabbro.* Bosniaski, S. 1878.1–1878.3.—*Vicenza (Prov.), Chiavon.* ★Bassani, F. **1888.2**, 1892.2; Heckel, J. J. 1854.1,.5; Kner, R., & Steindachner, F. 1863.1; Lioy, P. 1865.1; Lioy, P., & Rumor, S. 1901.1; Zigno, A. 1852.1; *Remarks on Bassani, F.* Gorjanovič-K., D. Add. 1889.1.

Maltese Is.: *Malta I.* Bassani, F. 1914.1; Cooke, J. H. 1896.1; Owen, R. 1865.1; Woodward, A. S. 1887.4.

Russia: *Trans-Caucasia, Apsheron Peninsula.* Kwitka, S. K. 1901.1; Bogacev, V. V. Add. 1913.1; Lednev, N. M. Add. 1914.1.

San Marino *(Republic), Monte Titano.* Angelis d'Ossat, G. 1896.1; Lawley, R. 1882.1; Trabucco, G. 1906.1; Nelli, B. Add. 1906.1.

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Sicily: *Girgenti (Prov.).* Gemmellaro, G. G. 1857.1; Gemmellaro, M. 1912.1; Heckel, J. J. 1853.2; Gregorio, A. Add. 1881.1; *Licata.* Sauvage, H. E. 1870.3, 1871.1, 1873.2, 1874.6, 1881.3; *Racalmuto.* Pollini, C. 1891.1.—*Palermo (Prov.).* Gemmellaro, M. Add. 1914.1.—*Syracuse (Prov.), Ragusa.* Gemmellaro, M. Add. 1914.2.

Spain: *Murcia (Prov.), Lorca.* Sauvage, H. E. 1875.3; Botella y de Hornos, F. Add. 1868.1.

Palæontology — *Cont'd.*

Switzerland: Baltzer, A. 1889.1; Kissling, E. 1902.1,.2; Letsch, E. 1899.1; Musy, M. 1913.1; Würtenberger, T. 1900.1,.2.

Oceanica

Australia: Chapman, F., & Pritchard, G. 1904.1.—*Victoria.* M'Coy, F. 1866.1.

New Zealand: Davis, J. W. 1888.1, 1889.1; Hector, J. Add. 1894.1.

PLIOCENE

Africa

Egypt: *Wadi-Natrùn or Natron valley.* Stromer, E. 1904.3, 1905.1, 1914.2; Studer, T. 1899.1.

North America

United States: *California.* Jordan, D. S. 1907.3.—*Colorado.* Cope, E. D. 1874.3.—*Idaho.* Cope, E. D. 1871.12, 1872.10, 1883.4,.6.—*Illinois.* Cope, E. D. 1894.2.—*Oregon.* Cope, E. D. 1878.3, 1883.6.

South America

Argentina: *Paranà.* Alessandri, G. 1895.2; Sangiorgi, D. 1901.1; Woodward, A. S. 1900.9.

Asia

India: *Siwaliks.* Günther, A. 1881.3; Lydekker, R. 1886.1, Add. 1882.1, 1886.1; M'Clelland, J. 1844.2.—*Rangoon, Irrawaddy series.* Pilgrim, H. G. 1906.1.

Siberia: Bogacev, V. V. 1908.1.

Europe

Austria-Hungary: *Szerem.* Koch, A. 1904.4, 1906.1.

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British Is.: *England. Crag beds of Suffolk and Norfolk.* Prestwich, J. 1871.1. —*Suffolk* (*Co.*), *Coralline crag.* Woodward, A. S. 1890.1.—*Red Crag.* Charlesworth, E. 1837.1,1838.1; Woodward, A. S. 1894.3.

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France: *Hérault* (*Dept.*), *"Sables marins de Montpellier."* Doncieux, L. 1905.1; Faujas de Saint-Fond, B. 1809.1; Gervais, F. L. 1855.2; Leriche, M. 1906.3, 1907.3; Priem, F. 1904.4, 1912.4; Rütimeyer, C. L. Add. 1857.1; Rivière, Pre-Linn. 1708.1.

Italy: *Bergamo* (*Prov.*), *Pianico.* Bassani, F. 1888.4.—*Bologna* (*Prov.*). Schubert, R. J. 1907.2.—*Calabria* (*Comp.*), *Calanna.* Stefano, G. 1901.1, 1912.3.—*Emilia* (*Prov.*). Schubert, R. J. 1906.1; Stefano, G. 1911.1, 1912.1.—*Messina* (*Prov.*). Seguenza, L. 1900.1.—*Parma and Piacenza* (*Provs.*). Carraroli, A. 1897.1.—*Piacenza* (*Prov.*), *Castell Arquato.* Brunati, R. 1909.1.—*Potenza* (*Prov.*). Bassani, F. 1901.1.—*Reggio* (*Prov.*), *Calabria.* Seguenza, L. 1901.1.—*Siena* (*Prov.*), *S. Giovanni.* Barbolani di Montauto, G. Add. 1910.1.—*Tuscany.* Bassani, F. 1901.4; Sacco, F. 1886.1, 1905.1; Sismonda, E. 1861.1; *Tuscany, Pisa* (*Prov.*), *Orciano.* Stefano, G. 1910.1; *Pisa* (*Prov.*) *Volterra.* Davis, J. W. 1887.1; Delfortrie, E. 1876.1; Gervais, F. L. P. 1875.1; Lawley, R. 1875.1–1878.4; Major, C. I. 1879.1; Meneghini, G. 1864.1–1866.1; *Val d'Arno, near Florence.* Simonelli, V. 1889.1.

Netherlands: *Limburg* (*Prov.*), *Tegelen-sur-Meuse.* Newton, E. T. 1908.1; Reid, C., & Reid, E. M. 1907.1.

Oceanica

D. E. I., Java (*Pithecanthropus strata*). Hennig, E. 1911.1.

PLEISTOCENE

For fish remains in kitchen middens; in caverns and grottos and in other associations with early man, *see under* Archæology.

North America

Canada: *Ottawa river, Greens creek.* Dawson, J. W. 1890.1.

United States: *California.* Arnold, R. 1903.1.—*Florida, Peace creek.* Leidy, J. 1889.1.—*Nevada, Hazen.* Hay, O. P. 1907.1.

Asia

Japan: *Tokio.* Tokunaga, S. 1906.1.

Europe

England: Abbott, W. J. 1908.1.—*Preglacial Forest Bed series.* Newton, E. T. 1882.1, 1901.1, *Grays Thurrock area.* Add. 1900.1.—*Essex* (*Co.*), *Ilford.* Johnson, J. P. 1901.1.—*Norfolk* (*Co.*), *Mundesley.* Lyell, C. 1840.1, 1842.1.—*Oxford and Wanstead dist.* Hinton, M. A. 1900.1.

France: *Allier* (*Dept.*). Pomel, A. Add. 1844.1, 1846.1, 1853.1.

Germany: Keilhack, F. L. Add. 1883.1. —*Saxe-Meiningen, Saalfeld.* Richter, R. 1879.1.

Italy: *Lecce* (*Prov.*), *"Terra d'Otranto."* Bassani, F. 1905.1.

Norway: (*Glacial marl.*) Collett, R. 1877.1, 1880.2; Sars, M. 1864.1, 1867.1.

Sweden: Holst, N. O. 1906.1; Munthe, H. W. 1910.1; Sernander, R. 1902.1.

PANCREAS

For allied organs, *see under* Alimentary tract, *and* Liver.

For the functions of the pancreas, *see* Intestinal digestion *under* Digestion.

Changes in pancreas in activity and rest (*salmon*). Gulland, G. L. 1898.1. —*Innervation and circulation.* Pensa, A. 1905.1. —*Structure in relation to function.* Strickland, J. G. & Earle, H. G. 1909.1.

Anatomy. *Miscellaneous and general.* Alessandrini, A. 1833.1, 1836.1; Brockmann, H. 1846.1; Harting, P. 1873.4; Laguesse, G. E. 1895.1, Add. 1891.1,.2; Massari, G. 1898.1; Stannius, F. H.

1848.1; Bernard, C. Add. 1849.1, 1856.1, 1879.1; Blasius, G. Pre-Linn. 1673.1; Commelin, C. Pre-Linn. 1667.1.

Anatomy in Cyclostomata. — Petromyzon. Giacomini, E. 1900.3; Picqué, R. 1913.1. —*Ammocœtes.* Kupffer, C. W. 1893.2. —*Cyclostomata.* Legouis, S. 1882.1. —*Bdellostoma.* Maas, O. 1896.1, *Myxine.* 1897.1.

In Dipnoi and Ganoidei. — Protopterus. Laguesse, G. E. 1890.1. —*Acipenser, Amia, and Lepidosteus.* Macallum, A. B. 1886.1.

In Elasmobranchii. — Chimæra. Costa, O. G. 1847.1. —*Galeus.* Laguesse, G. E. 1902.1.

In Teleostei. Krüger, Albert 1905.1; Woodland, W. N. 1911.3; —*Crenilabrus.* Laguesse, G. E. 1895.1. —*Amiurus.* Macallum, A. B. 1884.1.

For the most valuable treatises on the pancreas of Teleostei, see ★Legouis, S. **1870.1, 1873.1.**

Pancreatic ducts, structure and development. Laguesse, G. E. 1893.1. —*Acipenser.* Lavrov, S. 1908.2. —*"Weberian tubes" or pancreatic ducts.* Legouis, S. 1870.1, 1873.1.

Alleged absence of pancreas in Ostracion. Plancus, J. Pre-Linn. 1741.1.

Development. *Miscellaneous and general.* Brunn, A. W. 1896.1; ★Choronshitsky, B. 1900.1; Kupffer, C. W. 1892.1; Laguesse, G. E. 1893.1.

Development in Cyclostomata. — Ammocœtes. Brachet, A. 1897.1. —*Petromyzon.* Giacomini, E. 1902.2; Picqué, R. 1913.1.

In Dipnoi and Ganoidei. — Ceratodus. Neumayer, L. 1904.1,.3. —*Acipenser.* Nicolas, A. 1904.1. —*Amia.* ★Piper, H. 1902.1,.3.

Development in Elasmobranchii. ★Brachet, A. 1896.1; Laguesse, G. E. 1894.2; Mayr, J. 1897.1; Scammon, R. E. Add. 1914.1.

In Teleostei. Goeppert, E. 1893.1; Laguesse, G. E. 1889.1, 1894.1. —*Trout.* Stöhr, P. A. 1893.1; Stricker, F. 1899.1.

Histology of pancreas. *General account.* ★Oppel, A. Add. **1900.1.**

Islands of Langerhans, histological structure and physiological significance. — Histology. ★Diamare, V. 1899.2; Osawa, G. 1913.1. Laguesse, G. E. (*Elasmobranchii*) 1902.2; Vincent, S. & Thompson, F. D. 1907.1,.2. Rennie, J. (*Teleostei*) 1903.1, 1904.1. —*Physiological significance.* Diamare, V. & Kuliabko, A. 1904.1; Rennie, J. (*Lophius*) 1905.1.

Epithelial cyst in Petromyzon. Diamare, V. 1901.1.

PARASITES OF FISHES

This section relates specifically to the organisms living as parasites on fishes. For an intimately related section dealing more specifically with pathogenic organisms and the diseases they cause, *see* Pathology of fishes.

For larger organisms destructive to fishes, such as other fishes, birds, mammals, etc., *see* Noxious organisms *under* Pisciculture.

For the mutualistic association of fishes with hydroids, medusæ, molluscs, etc., *see* Commensalism and symbiosis.

The subject of parasitology is so vast and the literature so extensive that it should be obvious that the present treatment is intended to be suggestive rather than exhaustive. Those interested in finding the more recent literature and the descriptions of new species of parasites are referred to the "Zoological Record."

Discovery of parasitic borings in fossil fish scales. Rose, C. B. 1855.1.

The study of parasites as a clue to the migrations of fishes. Ward, H. B. 1908.1, 1909.1.

Popular article on parasites, with bibliography. ★Ward, H. B. 1912.1.

Parasites of the fishes — Orthagoriscus. Elwes, E. V. 1909.1; Beneden, P. J. Add. 1856.3; Leidy, J. Add. 1890.1. —*Malopterurus.* Fritsch, G. T. 1886.3. —*Poronotus triacanthus.* Linton, E. 1906.1, 1910.1. —*Chimæra.* Olsson, P. H. 1896.1. —*Salmo salar.* McIntosh, W. C. 1864.1; Tosh, J. R. 1905.1; ★Ward, H. B. 1910.2. —*Regalecus.* Monticelli, F. S. Add. 1900.1.

Parasites of fishes in various localities. —*Madras* (*List*). Bell, F. J. 1884.1. —*Belgium.* Beneden, P. J. 1871.1. —*Jamaica.* Wilson, C. B. 1911.1. —*Balaton Lake.* Rátz, S. Add. 1897.1.

Parasites of British marine fishes. Nicoll, W. 1909.1, 1910.1; Scott, A. 1903.1; Scott, T. 1902.1, 1904.1, 1905.1.

Germany, including North and Baltic Seas. Piesbergen, F. 1886.1; Schultz, G. 1911.1; Voigt, M. 1903.1; Wegener, M. 1910.1; Zschokke, F. 1891.1.

Italy and Switzerland. ★Nufer, W. 1905.1; Sonsino, P. 1891.1; Stingelin, T. 1896.1; Condorelli-Francaviglia, M. Add. 1898.1,.2.

CRUSTACEAN PARASITES

Order Copepoda

(Attached to the gill filaments or the walls of the gill chamber, or to the skin or fins.)

Enumeration of known species. ★Bassett-Smith, P. W. 1899.1 —*Review of this.* Poche, F. 1902.1.

Lists of, and treatises on American forms. Rathbun, R. 1902.1 (*Should be 1884*); Smith, S. I. 1874.1; ★Wilson, C. B. 1902.1–1911.4, Add. 1905.1–1913.1.

In addition to these papers, ★Prof. C. B. Wilson *has since published comprehensive treatises on North American parasitic copepods belonging to the various genera or families as follows: "Genus Lernæa,"* Bull. U. S. Bur. Fish., 1915–1916 (1918), vol. 35, pp. 165–198, 10 pls. "*Lernæidæ.*" Proc. U. S. Nat. Museum, 1917, vol. 53, pp. 1–150, 21 pls. "*Sphyriidæ.*" *Ibid,* 1920, vol. 55, pp. 549–604, 10 pls. "*Dichelesthiidæ,*" *ibid,* 1922, vol. 60, pp. 1–100, 13 pls.

Parasitic copepods of Central Europe. Hofer, B. 1904.2.

For a valuable treatise with colored plates see "The British Parasitic Copepoda," *by*

Parasites — *Cont'd.*

★Thomas & Andrew Scott, 2 vols., Ray Soc., London, 1913.

A similar treatise in Italian, also containing colored plates, is " Copepodi parassiti dei Pesci d'Italia " *by* A. Brian. Geneva, 1906, 189 p., 21 plates.

Various papers on parasitic copepods. Bassett-Smith, P. W. 1896.1, 1898.1, 1899.1, Add. 1895.1, 1898.1,.2; Beneden, P. J. 1851.1, 1852.1, 1855.1, 1857.2,.3, Add. 1851.1; Brian, A. 1908.1, Add. 1899.1; Brotherson, A. 1879.1; Calderwood, W. L. 1906.2; Cornalia, E. 1875.1; Giard, A. 1888.2, Add. 1889.2; Grube, A. E. 1873.1; Haempel, O. 1907.1; Hjort, J. 1895.2; Kneeland, S. 1858.1; Neresheimer, E. 1909.2; Valle, A. 1880.1; Wright, R. R. 1882.1; Candiotti, C. Add. 1910.1; Kellicott, D. S. Add. 1880.1, 1887.1, 1892.1; Leidy, J. Add. 1888.1,.3, 1890.2; Scott, T. Add. 1900.1.

Sub-order EUCOPEPODA

Ergasilidæ including Bomolochinæ. American forms. ★Wilson, C. B. **1911.2.**

Chondracanthidæ; various items. Delaroche, F. E. 1810.1; Rathbun, R. 1886.1; Vogt, C. C. 1877.1; Turner, W. & Wilson, S. H. Add. 1864.1.

Philichthyidæ, miscellaneous. Quidor, A. 1910.1; Vogt, C. C. 1877.1.

Lernæidæ. Various papers on the genus Lernæa. Baird, W. 1861.1; Goeze, J. A. 1784.1; Koelreuter, J. G. Add. 1775.1; ★Scott, A. Add. 1900.2. —*Lernæenicus sprattæ, parasitic on eye of Clupea sprattus.* Baudouin, M. 1904.1–1908.1; Cligny, A. 1905.3; Joubin, L. 1888.1,.2; Richiardi, S. Add. 1880.1. — *Penella remoræ of Remora.* Murray, A. 1856.1. — *P. filosa in Othagoriscus.* White, J. C. 1856.1.

Lernæopodidæ, various papers. Neresheimer, E. 1909.3; Vogt, C. C. 1877.1; Wilson, C. B. 1908.1, 1911.3,.4; Wright, R. R. 1882.1. —*Lernæopoda edwardsii Wright, cause of epidemic at brook-trout hatchery in Wisconsin.* Fasten, N. 1912.1,.2.

Fasten has since published in Pubs. Puget Sound Biol. Station, 1918, vol. 2, no. 36, pp. 73–76, pl. 18; *and in the* American Naturalist, 1921, vol. 55, pp. 449–456.

Fasten, according to Prof. C. B. Wilson, has devised the only known practicable method for the eradication of copepods and this is effective only before or during the early stages of the parasite's attachment. Frequent salt baths consisting of a 2.50 % solution of sodium chloride in which the fry may be left 3 or 4 hours will kill the parasites. Likewise a 1 or 2% solution of potassium chlorate or a 2% solution of magnesium sulphate is equally effective.

Sub-order BRANCHIURA

Argulidæ, European forms. Léger, L. 1906.1; Perrier, L. 1909.2; Ströbel, L. 1914.1; Hamel, E. D. Add. 1870.1.

American forms. ★Wilson, C. B. **1902.1**–1908.1.

Argulus, cause of epidemic among whitefish in Minnesota. Washburn, F. L. 1886.1; Wright, R. R. 1887.1.

Order Isopoda

Cymothoidæ, including the sub-families Cymothoinæ and Cirolaninæ. Parasitic in mouth and gill cavities and more rarely on the skin or fins of fishes. Less specialized parasites than copepods and capable of freely exchanging hosts.

Various topics. — *Conilera destroying a captured shark.* Day, F. 1884.2. — *Taxonomic and natural history.* Herklots, J. A. 1870.1; Lütken, C. F. 1858.1.

For the "natural·history of the Isopoda," see Richardson, H. *in* Proc. U. S. Nat. Mus., 1904, vol. 27, 1–89.

The most comprehensive systematic treatises are ★Schioedte, J. C. & Meinert, F. "De Cirolanis Ægas simulantibus." Commentatio brevis, Naturhist. Tidsskr., 1879, (3) XII, pp. 279–302, pls., *and especially their* "Symbolæ ad Monographiam Cymothoarum, Crustaceorum Isopodum Familiæ." Naturhist. Tidsskr., 1879–1884, (3) XII, pp. 321–414, pls.; XIII, pp. 1–66, 281–378, pls.; XIV, pp. 221–454, pls.

For an account in English of the European marine Cirolaninæ, see Hansen, H. J. *in* Journ. Linn. Soc. London, Zool., 1905, XXXIX, pp. 337–373, pls.

MOLLUSCAN PARASITES

The glochidia or larvæ of freshwater mussels (Unionidæ) live parasitically within a cyst formed by the epidermis of the fish parasitized. Such parasitism persists from one to several months before metamorphosis occurs and the young mussel begins a free life.

Various papers on methods of implantation of the glochidium, specific hosts, etc. Conner, C. H. 1905.1; Howard, A. D. 1913.1, Add. 1914.1,.2,.3; ★Lefevre, G. & Curtis, W. C. 1910.1, Add. 1910.1; Leonhardt, E. E. 1905.22; Young, D. 1911.1; Faussek, V. A. Add. 1895.1, 1901.1; Surber, T. Add. 1914.1.

PROTOZOAN PARASITES

All references to Protozoan parasites, generally but not always pathogenic, have for the sake of convenience been placed in the section Pathology of fishes. *In that section, see under* Diseases caused by Sporozoan parasites; Diseases of the blood; *and* Diseases of the gills and skin.

WORM PARASITES

General treatises or compendia of helminthology. Hofer, B. 1904.2; ★Linstow, O. **1878.1.**

An invaluable work for the specialist, with records of occurrence and detailed references to the literature of each species of trematode, cestode, and roundworm, is the "Index-Catalogue" *to which detailed references are given below under these groups. This work is a continuation of and an index to* ★Stiles, C. W. & Hassall, A. **1902.1.**

Miscellaneous or unclassified references to "entozoa" or worm parasites. Annone, J. J. 1759.1; Barbagallo, P. & Drago, U. 1903.1; Gressner, - 1867.1; Levander, K.

M. 1901.3, 1909.1; Lunel, G. 1880.2; Nicoll, W. 1909.1, 1910.1, Add. 1907.1; Oerley, L. 1885.1,.3; Perrot, L. 1819.1; Ward, H. B. 1894.2,.3; Zschokke, F. 1903.1, Add. 1891.1, 1896.1; Acharius, E. Add. 1780.1,.2; Cobbold, T. S. Add. 1873.1,.2, 1876.1, 1880.1; Condorelli-Francaviglia, M. Add. 1898.1,.2; Furnell, M. C. Add. 1884.1; Prenant, A. Add. 1886.1.

Early references in Pre-Linn. *section.* Frisch, J. 1727.1–1734.2; Garsin, L. 1730.1; Geoffroy, C. 1710.1; Rongeard, – 1723.1. — *Translations of Frisch, J.* Frisch, J. L. Add. 1781.1–.4.

Phylum Platyhelminthes

Class Turbellaria

Sanguinicola (Family Rhynchostomidæ) living in blood of carp and tench. Rhabdocoels with greatly reduced pharynx. First known Turbellarian, parasitic in vertebrates. Plehn, M. 1905.1, Add. 1905.1.

Class Trematoda

For a comprehensive treatise on Trematodes, with references to the literature and detailed lists of hosts, consult the article by ★M. Braun *in* Bronn's "Klassen und Ordnungen des Thier-Reichs," Bd. iv, Abth. 1a, 1879–1893, pp. 303–925.

The part of the bibliography of ★Stiles, C. W. & Hassall, A. 1902.1, *dealing with trematodes, is the* "Index-catalogue of medical and veterinary zoology. Subjects: Trematoda and trematode diseases." Bull. 37, Hygienic Lab., U. S. Public Health Service, Washington, 1908, 398 p.

Miscellaneous papers on Trematoda throughout the world. Ambrose, J. 1890.1; Daday, J. 1905.1, 1907.1; Delaroche, F. E. 1810.1; Goldberger, J. 1911.1; Linton, E. 1898.3, 1912.3; Marshall, W. & Gilbert, N. C. 1905.2; Parona, C. & Perugia, A. 1889.1–1892.1, Add. 1890.1–1896.1; Perugia, A. 1895.1, 1896.1; Scott, T. 1911.1; Stafford, J. 1902.1, 1904.1, 1905.1, 1907.1, Add. 1904.1; Zacharias, E. O. 1893.1; Ariola, V. Add. 1899.1; Hausmann, L. Add. 1896.1; Luehe, M. Add. 1906.1; Maclaren, N. Add. 1903.1; Sonsino, P. Add. 1890.1, 1891.1.

Order HETEROCOTYLEA

(Chiefly ectoparasites; in fishes, infesting the gills and skin.)

Microcotyle. MacCallum, G. A. 1913.2, .3; MacCallum, G. & MacCallum, W. G. 1913.1. — *Squalonchocotyle borealis, parasitic on sleeper shark.* Ward, H. B. 1910.5.

Tristomum. Bell, F. J. Add. 1891.1; Setti, E. Add. 1898.1. — *Epibdella.* Beneden, P. J. Add. 1856.2; Schoett, H. Add. 1896.1. — *Monocotyle.* Pratt, H. S. Add. 1910.1.

Gyrodactylus, the cause of much trouble to the fish culturist. Bradley, C. L. 1861.1; ★Kathariner, L. 1895.1; Leonhardt, E. E. 1905.11; Ryder, J. A. 1884.6.

Treatment of Gyrodactyliasis. Hofer, B. 1902.1, 1904.2; Usakov, B. 1907.1; Voskresenskiĭ, A. 1909.1.

Octobothrium sagittatum as a cause of pernicious anæmia. Hofer, B. 1903.2, 1904.2.

Order ASPIDOCOTYLEA

Macraspis elegans Olsson, parasitic in gall bladder of Chimæra. Olsson, P. H. 1896.1.

Aspidogaster ringens Linton, and A. kemostoma n. sp., parasitic in alimentary tract of pompano. MacCallum, G. A. & MacCallum, W. G. Add. 1913.1.

Order MALACOCOTYLEA

(Chiefly endoparasites, infesting the alimentary tract and gall bladder, although some species of Distomum occur in the gills.)

Amphistomum in notochord of Protopterus. Burckhardt, C. R. 1891.1. — *Clinostomum marginatum in American freshwater fishes.* Osborn, H. L. 1901.1, 1911.1, 1912.1. — *Cryptogonimus chyli, in black bass.* Osborn, H. L. 1903.1,.2, 1910.1.

Diplostomum or Holostomum cuticula, as cause of Diplostomiasis. Linton, E. 1898.3; Pavesi, P. 1881.1; Poppe, S. A. 1911.1; Gamble, F. W. & Drew, G. H. Add. 1911.1.

For the anatomical details of Distomum, see ★Looss, A. Add. 1894.1.

Various papers, chiefly on Distomum. Braun, M. G. 1894.2; Cobbold, T. S. 1867.1; Johnston, S. J. 1902.1; Leidy, J. 1851.1,.2, 1853.1, 1888.2; Linstow, O. F. 1907.1; Looss, A. 1901.1; Lühe, M. 1900.1; MacCallum, W. G. 1895.1, 1905.1; Macleay, W. 1877.1; Nickerson, W. S. 1900.1; Sinicyn, D. 1905.1, Add. 1906.1; Ward, H. B. 1894.1, 1901.1; Weyenbergh, H. 1875.1, 1877.2; Chavannes, A. Add. 1851.1; Schroeder, A. E. Add. 1895.1.

Class Cestoidea

(Tapeworms or Cestoda)

A valuable treatise is the article by ★M. Braun *in* Bronn's "Klassen u. Ordnungen," Bd. iv, Abth. 1b, 1894–1900.

The part of the bibliography of ★Stiles, C. W. & Hassall, A. 1902.1, *dealing with cestodes, is the* "Index-catalogue of medical and veterinary zoology. Subjects: Cestoda and Cestodarea." Bull. 85, Hygienic Lab., U. S. Public Health Service, Washington, 1912, 476 p.

Amphiptyches urna Wagener, from Chimæra and Callorhynchus. Haswell, W. A. 1902.2; Olsson, P. H. 1896.1; Scott, T. 1911.1; Spencer, W. B. 1899.1; Wagener, G. 1852.1.

Ligula (Riemenwurm) infesting cœlom and causing peritonitis or ligulosis. Fishes, chiefly cyprinids, are the intermediate hosts, the final hosts being aquatic birds. Miscellaneous papers. Leidy, J. 1856.5, 1873.4; Levander, K. M. 1904.1; Linton, E. 1891.5; Neveu-Lemaire, M. 1909.1; Parona, C. & Mazza, F. 1900.1; Willer, A. 1912.1; Davaine, C. J. Add. 1865.1; Donnadieu, A. L. Add. 1870.1. — *Mortality caused by Ligula.* Hofer, B. 1904.2; Rátz, S. 1893.1.

Tetracotylus percæ-fluviatilis, cause of epidemic in Italian lakes. Mazzarelli, G.

Parasites — *Cont'd.*

F. 1906.1; Piana, G. P. 1898.1, Add. 1898.1.

Systematic treatises on various genera. — Proteocephalus. Benedict, H. M. 1900.1, Add. 1902.1. —*Gyrocotyle.* Watson, E. E. 1911.1. — *Ichthyotænia.* Fuhrmann, O. 1903.1; La Rue, G. R. 1911.1; Zschokke, F. 1884.1; ★Riggenbach, E. Add. 1896.1.

Various unclassified papers on cestodes: Bothriocephalus, Tetrarhynchus, and various genera. Bergman, A. M. 1903.1; Bossuat, E. 1902.1; Cobbold, T. S. 1863.1; Duvernoy, G. L. 1842.1; Harvey, M. 1876.1; Haswell, W. A. 1902.1, Add. 1904.1; Hoek, P. P. 1879.1; Iverus, J. 1905.1; Kraemer, A. 1892.1,.2; Leidy, J. 1885.1, 1871.1, Add. 1879.2; ★Linton, E. 1889.1, 1891.1,.5, 1892.2, Add. 1889.1–1914.1; Lühe, M. 1902.1,.2; Macleay, W. 1877.1; Masi, L. 1912.1; Mola, P. 1903.1; Olsson, P. Add. 1872.2; Schneider, G. 1902.1,.2, 1903.1,.2,.14, 1904.18, 1905.5, 1910.1, 1911.2, Add. 1905.1,.2; Skorikov, A. S. 1902.1, 1903.1; Ariola, V. Add. 1899.2, 1900.1; Beneden, P. J. Add. 1849.1, 1889.1; Curtis, W. C. Add. 1890.1, 1911.1; Klaptocz, B. Add. 1906.1; Maclaren, N. Add. 1903.1; Marais de Beauchamp, P. Add. 1905.1; Mégnin, J. P. Add. 1881.1; Shipley, A. E. & Hornell, J. Add. 1906.1; Southwell, T. Add. 1911.1–1913.1.

For the occurrence of Dibothriocephalus latus in man, see Parasites of alimentary tract *under* Diseases of man.

Phylum Nemathelminthes

(Roundworms and Threadworms)

The part of the bibliography of ★Stiles, C. W. & Hassall, A. 1902.1, *dealing with roundworms, is the* "Index-catalogue of medical and veterinary zoology. Subjects: Roundworms (Nematoda, Gordiacea, and Acanthocephali) and the diseases they cause." Bull. 114, Hygienic Lab., U. S. Public Health Service, Washington, 1920, 881 p.

Another valuable compendium is ★Linstow, O. F. 1878.1.

The following references are not comprehensive and are given for what they may be worth.

Sub-order Nematoda

Ascaris, occurring usually in the intestine. Giard, A. 1903.3; Noël de la Morinière, S. 1804.1; Wright, R. R. 1879.1; Wyman, J. Add. 1844.1,.2.

Filaria, Ichthyonema, etc., parasitic usually in tissues. Bean, T. H. 1908.1; Leidy, J. 1878.1, 1883.1, 1886.1; Yarrell, W. 1832.2; Wedl, C. 1848.1; Baird, W. Add. 1861.1; Gemmill, J. F. & Linstow, O. Add. 1902.1.

Cystidicola farionis, a nematode, parasitic in air-bladder of trout. Fischer von Waldheim, G. Add. 1797.1, 1798.1; Shipley, A. E. Add. 1908.1.

Various papers on Nematodes. Roth, W. 1909.3; Fourment, L. Add. 1884.1; Martin, A. R. Add. 1771.1; Shipley, A. E. & Hornell, J. Add. 1906.1.

Sub-order Acanthocephala

Chiefly the genus Echinorhynchus of which the adult forms live in the alimentary canal of fishes, the larval forms occurring in crustacea or other fishes which are the intermediate hosts. Bieler, W. 1913.1; Diesing, K. M. 1854.1; Leidy, J. 1851.1,.2, 1890.1; Neveu-Lemaire, M. 1905.1,.2; Porta, A. 1904.1, 1905.1; Stephens, J. W. & Boyce, R. 1904.1; Yarrell, W. 1832.2; Desir, — Add. 1843.1; Hyatt, J. D. Add. 1896.1.

PARASITIC FISHES

For the association of fishes with Coelenterates, Echinoderms, Molluscs, etc., *see under* Commensalism.

Stegophilus (Pygidiidæ), parasitic in gill cavities of South American siluroids. Haseman, J. D. 1911.2; Lütken, C. F. 1880.5, 1891.1; Pellegrin, J. 1912.6; Reinhardt, J. T. 1859.1, 1860.1.

Vandellia (Candiru), as a parasite. Pellegrin, J. 1909.12,.17, 1912.6; Ribeiro, A. 1911.1.

Alleged penetration of the urethra of bathers by the "Candiru." Boulenger, G. A. 1897.6; Castelnau, F. 1855.1; Jobert, C. 1898.1; Marcoy, P. 1869.1; Orton, J. 1870.1; Poeppig, E. 1835.1; Schomburgk, R. H. 1840.1; Spix, J. B. & Agassiz, L. 1829.1; Spix, J. B. & Martius, C. F. 1823.1; Lange, A. Add. 1912.1; Woodroffe, J. F. Add. 1914.1.

For a recent summary, see ★Eigenmann, C. H. *in* Mem. Carnegie Mus., 1918, *vol.* 7, *pp.* 261–269.

Parasitic habits of the Lamprey eels. Jürgens, W. 1911.1; Robertson, D. 1875.1; Smith, W. S. 1905.1; Surface, H. A. 1898.1, 1899.1; Anon. 612. — *Non-parasitism of the Brook-lamprey.* Gage, S. H. 1911.1.

Data on parasitism among the various Cyclostomes will probably be found under the fishes in the Systematic Part, *particularly under the headings* General accounts, *and* Natural History.

PATHOLOGY OF FISHES

With some necessary modifications, the arrangement of this section follows that used in the "Handbuch der Fischkrankheiten" of B. Hofer, cited below. The German vernacular names in this treatise are here repeated.

For an intimately related section, not clearly separable but dealing more specifically with organisms whose presence is not generally pathogenic, *see the section on* Parasites of fishes.

For all abnormalities in structure and development such as double monstrosities, curvature of the spine, etc., *see under* Teratology.

For the association of fishes with human diseases, *see* Diseases of man.

For the pathological effects of refuse of factories, refineries, etc., *see* Depletion *under* Fisheries.

For the destruction of fishes by natural causes, earthquakes, hurricanes, etc.; causes of winter-killing, etc., *see under* Mortality.

General treatises. (*Causes, treatment, etc.*)

Text in French. Girdwoyń, M. 1880.1; Drouin de Bouville, R. Add. 1909.1; Rayer, P. F. Add. 1843.1.

Text in German. ★Hofer, B. 1901.1, 1902.1, **1904.2**; Roth, W. 1912.1; Stansch, K. 1911.4.

Miscellaneous references. *Unclassified items on fish diseases.* Atkins, C. G. 1902.1; Bean, T. H. 1910.11; Buniva, M. F. 1802.1; Drew, G. H. 1910.1; Emeljanenko, P. E. 1907.3; Fuhrmann, O. 1905.4; Hendschel, – 1878.1; Huxley, T. H. 1883.1; Johnstone, J. 1905.4, 1909.2, 1910.2; Körner, O. 1877.1; Lion, – 1867.1; Pleskott, E. 1878.1; Roth, W. 1910.1,.2; Schiemenz, P. 1916.1; Seal, W. P. 1889.2; Szilady, Z. 1908.1; Williamson, H. C. 1911.2,.3; Sticker, A. Add. 1893.1.

Researches carried on at Vienna Tierärztliche Hochschule. Fiebiger, J. 1908.1, 1909.2, 1910.1.

VARIOUS PATHOLOGICAL CONDITIONS

Degeneration or reabsorption of eggs in ovary. Barfurth, D. 1886.1,.2; Bühler, A. 1902.1.

"White spot" disease of salmon, affecting skin of the head. Cause unknown, supposedly due to retention in salt water bays because of low stage of rivers in migration time. Calderwood, W. L. 1905.3.

Ovarian cyst, caused by Trypanosomes. Chifflot, Conte & Vaney 1907.1.

Fatty degeneration of heart musculature as a secondary result of infection by the trematode, Octobothrium sagittatum. Hofer, B. 1903.2, 1904.2.

Relation of acidity of water to disease. Knauthe, K. 1908.1.

Gas disease, caused by excessive content of dissolved air in the water. Gorham, F. P. 1901.1; Marsh, M. C. 1904.1, 1908.1; Marsh, M. & Gorham, F. 1905.1. — *Notice of this.* Osgood, W. H. 1904.1.

Renal mycosis in carp. Verdun, P. 1903.1.

Ulcerative disease of the eel (rote Beulenkrankheit). Bergman, A. M. Add. 1909.1.

Implantation of selachian embryo in spleen. Gargano, C. Add. 1914.1.

Hyperostosis or thickening of bones, considered hereditary. Köstler, M. 1882.1.

A case of exostosis. Sutton, J. B. Add. 1888.1.

Calculi or concrements, *including their chemical analysis.* — *Unclassified.* Fourcroy, A. & Vauquelin, L. 1807.1. — *Intestinal calculus of sturgeon.* Delachanel, B. & Mermet, A. 1874.1; Harting, P. 1875.2; Oseretskovsky, N. 1782.1; Collinson, P. Pre-Linn. 1748.1. — *Kidney concretions.* Rudolphi, C. A. 1816.1.

Biliary calculi of Cynoscion. Tower, R. W. 1902.1.

Carcinoma of the thyroid (*Cancer or endemic goitre*). *Prevalent especially in Salmonidæ. Cause unknown (Bösartiger Kropf).*

General treatise with full bibliography. ★Gaylord, H. & Marsh, M. Add. **1914.1.**

First notice of this disease. Bonnet, R. 1883.1. — *Recognition as carcinoma.* Scott, – Add. 1892.1.

Various papers, occurrence, prophylaxis, etc. Meehan, W. E. 1912.1; Plehn, M. 1902.1, 1904.1; Gaylord, H. R. Add. 1909.1, 1910.1, 1912.1; ★Gaylord, H. & Marsh, M. C. Add. 1912.1,.2; Gilruth, I. A. Add. 1902.1; Jaboulay, – Add. 1908.1; ★Marine, D. & Lenhart, C. 1910.1, Add. 1910.1–1911.2; Marsh, M. C. Add. 1910.1, 1914.1; Osburn, R. C. 1911.3, Add. 1914.2; ★Pick, L. Add. 1905.1; Smith, H. M. Add. 1909.1.

Diseases of eye. (*Lernæenicus sprattæ, a parasitic copepod, when attached to the eye of the sardine causes partial or total blindness. For references see* Lernæidæ *below* Crustacea *under* Parasites.)

Exophthalmia or protusion of the eye, a symptom often of the gas disease recorded above, or due to infection. Audigé, J. 1903.1, 1904.2; Pettit, A. 1903.1; Plehn, M. 1906.3. —*Exophthalmia caused by Bacillus collogenes.* Terni, C. 1906.1–1908.2.

Cataract or other injury, caused by various encysted parasites. Bean, T. H. 1911.16; Fuhrmann, O. 1904.1; Trojan, E. Add. 1909.1.

Opacity and perforation of the cornea, caused either by water polluted by iron, or by external injury to the eye. Bullen, G. E. 1913.2; Day, F. 1882.1; Leuckart, R. 1886.1.

Diseases of nervous system *caused by parasites.*

Worms encysted in brain or nerves of fishes. Brown, Albert W. 1899.1; Maddox, R. L. 1867.1; Mataré, F. 1910.1.

Myxosporidia in nervous system. Schuberg, A. & Schroeder, O. Add. 1905.1. — *Lentospora encephalica of carp.* Mulsow, K. 1911.2. —*Glugea lophii in ganglia of Lophius.* Weissenberg, R. 1911.1,.2,.3.

"Taumelkrankheit" of Salmonidæ, caused by an infection of the internal organs, especially the brain, by parasites, probably sporozoan. Hofer, B. 1893.1; Laveran, A. & Pettit, A. 1910.1; Mulsow, K. 1911.3; Plehn, M. & Mulsow, K. Add. 1911.1.

Neoplasms; tumors, etc. *Chiefly minor notes on their microscopic structure, occurrence, etc.* Deslongchamps, J. A. 1853.3; Drew, G. H. 1912.1; Gluge, G. 1841.1; Lawrence, G. 1895.1; McIntosh, W. C. 1885.2, 1908.1; Pesce, P. A. 1907.1; Prince, E. E. & Steven, J. L. 1892.1; ★Sandeman, G. 1893.1; Siebold, C. T. 1861.2; Tait, L. 1870.1; Wilms, M. 1895.1; Anon. 120.

"Egg-cells" in skin of Macropodus. Zschiesche, A. 1910.1.

DISEASES CAUSED BY BACTERIA

Miscellaneous papers on bacterial diseases. Bean, T. H. 1907.3; Ogle, J. W. 1873.1; Richet, C. Add. 1882.1.

Pathology — *Cont'd.*

Typhus epidemics in Lake Geneva, Switzerland, 1867, 1868, and 1873. Forel, F. A. 1866.1, 1874.1; Forel, F. A. & Du Plessis, G. 1868.1; Pétavel, J. 1868.1.

Bacillus. *Bacillus sp. affecting trout at Velars, Côte d'Or, France.* Bataillon, E. 1894.1.

Bacillus piscicidus versicolor, cause of epidemic at Bukarest, 1902. Babes, Y. & Riegler, R. 1905.1.

Bacillus pestis Astaci, cause of scale disease or "Lepidorthosis contagiosa" of Cyprinidæ (Krebspest or Schuppensträubung). Plehn, M. 1902.2.

Bacillus piscicidus agilis. (Affecting especially Lucioperca sandra.) Sieber, N. 1895.1, Add. 1894.1.

Ulcerative septicæmia. Cause: Bacillus sp. —*In trout.* Bataillon, E. & Dubard, – 1895.1. —*In goldfish.* Ceresole, J. 1900.1. —*In plaice.* Riddell, W. & Alexander, D. 1912.1. —*Outbreak on Bay of Nigg, Scotland.* Anderson, A. Y. Add. 1911.1.

Bacillus collogenes, cause of exophthalmia. Terni, C. 1906.1–1908.2.

Bacterium. *Unidentified bacterium, cause of mortality in Rhone R., 1892. Possibly identical with Bacterium vulgare.* Charrin, A. 1893.1.

Bacterium truttæ affecting brook-trout. Marsh, M. C. 1902.1, 1903.1, 1904.2, 1907.1.

Bacterium cyprinicida Plehn, occurring especially in blood and kidneys, and cause of "Purpura cyprinorum" (Rotseuche der karpfenartigen Fische). Plehn, M. 1903.1; Spieckermann, A. & Thienemann, A. 1911.1; Thienemann, A. 1911.5.

Bacterium vulgare Wyss, cause of "Xanthosis leuciscorum" of Leuciscus rutilus in Lake Zürich, 1897 (Gelbseuche der Rotaugen) Wyss, O. 1898.1.

Furunculosis of Salmonids. *Cause: Bacterium salmonicida Em. & W.* Drouin de Bouville, R. 1910.1; Edwards, A. M. 1863.1; ★Emmerich, R. & Weibel, E. 1894.1; Hofer, B. 1898.2, 1901.4; Murisier, P. 1910.2; Neresheimer, E. 1911.3; Surbeck, G. 1909.3, 1910.5, 1911.5,.6; Fabre-Domergue, P. Add. 1890.1; Plehn, M. Add. 1911.2.

Pestis rubra anguillarum, *epidemic especially in Lake Comacchio, Italy. Cause: probably Bacillus anguillarum (Rotseuche des Aals).* Canestrini, G. (*Cause discovered*) 1893.1; Hofer, B. 1897.1; Hofer, B. & Doflein, F. J. 1898.1; Inghilleri, F. 1903.1, 1904.1; Nardo, G. D. 1866.1,.2,.3; Ninni, A. P. 1868.1; Sennebogen, E. 1902.1.

Pestis salmonis or Salmon disease. *Cause: Bacillus salmonis pestis, discovered by Patterson in 1903, associated with Saprolegnia which had been previously considered the primary cause.*

Papers on the salmon disease, epidemic in England, Scotland, and Wales, 1877–1882. Brook, G. 1877.1, 1879.1; Brotherson, A. 1883.1; Buckland, F. T. 1880.2; Buckland, F. T., Walpole, S. & Young, A. 1880.1; Christison, R. 1879.1; Clark, John 1883.1; Dougall, J. 1882.1; Huxley, T. H. 1882.1; ★Huxley, T. H. & Walpole, S. **1882.1**; ★Murray, G. 1885.1; Robson, M. A. 1880.1; Rutherford, J. 1881.1, Add. 1880.1; Smith, W. A. 1883.3; Stirling, A. B. 1878.1, 1879.2; Vion, R. 1879.2; Walker, W. 1879.1; Walpole, S. & Huxley, T. H. 1882.1; Archer, W. E. Add. 1893.2; Edington, A. Add. 1889.2; Swan, A. P. Add. 1889.1.

Cause discovered. ★Patterson, J. H. **1903.1,** *in Pubs. Fishery Board for Scotland. 52 p., 10 pls.*

Epidemic in Kura R., Russia. Arnold, J. N. 1901.1. —*at Maastricht, Netherlands, 1912.* Redeke, H. C. & Liebert, F. 1913.1.

For other papers on Saprolegnia, see Fungus growths *below, under* Diseases of the gills and skin.

Tuberculosis. *Cause: Bacillus tuberculosis piscium B. D. & T.* Bataillon, E., Dubard, –. & Terre, –. 1897.1; Ledoux-Lebard, –. 1898.1; Dubard, –. Add. 1897.1.

Attempts (unsuccessful) at induction of mammalian tuberculosis in fishes by ingestion. Virulent bacilli in fæces, no pathogenic effects on fishes. Germano, E. 1900.1; Herzog, H. 1902.1; Hormann, –. & Morgenroth, –. 1899.1; Nicolas, J. & Lesieur, C. 1899.1.

Review of piscine tuberculosis. ★Alexander, D. M. 1913.1. —*Renal tuberculosis in carp.* Hautefeuille, L. B. 1904.1.

DISEASES CAUSED BY SPOROZOA

For a valuable general and comprehensive treatise on the Sporozoa with lists of Sporozoan hosts and a bibliography, the reader should consult the article by ★E. A. Minchin *in* Lankester's Treatise on Zoology, part I, fasc. 2, London, 1903.

For the "Taumelkrankheit" of salmonids, probably caused by a Sporozoan, see above under Diseases of nervous system.

PHYLUM PROTOZOA
Class SPOROZOA
Sub-class TELOSPORIDIA

Coccidiidea (*Order*). *Parasites of epithelial cells chiefly of alimentary tract, liver, spleen, kidney, etc.* Elmassian, M. 1909.1; Fiebiger, J. 1907.2; Piraud, V. 1909.2; ★Thélohan, P. 1890.1, 1892.2; Wierjejski, A. 1898.1, Add. 1898.1; Labbé, A. Add. 1893.1.

Hæmosporidia (*Order*). *Blood parasites, chiefly in red blood-corpuscles. Their occurrence in fishes is not known to produce pathological effects.*

Hæmogregarina, new species, occurrence, habitat, etc. Brumpt, E. & Lebailly, C. 1904.1; Laveran, A. 1900.1, 1906.1; Laveran, A. & Mesnil, F. 1901.1, 1902.3; Lebailly, C. 1904.1–1906.1; Wenyon, C. M. 1911.1; Henry, H. Add. 1910.1, 1913.1; Oertel, A. Add. 1895.1.

Sub-class NEOSPORIDIA

Myxosporidia (Psorosperms of fishes). *Occurring in cavities of biliary or urinary organs or infesting connective or muscular tissues. Cause of virulent epidemics.*

General treatise, with complete review of literature to 1894. ★Gurley, R. R. **1894.1.**

Myxobolus chondrophagus Plehn, affecting the ear and associated parts and the cause of "staggers" or "Drehkrankheit" in the rainbow trout. Hofer, B. 1903.1, Add. 1903.1; Plehn, M. 1905.4, Add. 1904.1,.2; Vincent, E. 1910.1; Winter, F. W. 1905.1.

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DISEASES OF THE BLOOD

For sporozoan blood parasites see Hæmosporidia *above under* Diseases caused by Sporozoa.

Spirochætes, *flagellate protozoans, chiefly blood parasites but also including intestinal forms.* Duboscq, O. & Lebailly, C. Add. 1912.1, 1913.1; Henry, H. Add. 1912.1; Neumann, R. O. Add. 1909.1.

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DISEASES OF EGGS AND FRY

Diseases of eggs caused by chromogenic bacteria. Bonnet, R. 1883.1; Hofer, B. 1904.2, Add. 1898.4.

Fungi on fish eggs. Peter, G. A. 1884.1; Ryder, J. A. 1884.5; Berkeley, M. J. Add. 1864.1.

Hydrocœle embryonalis or yolk-sac disease of trout fry (Dotterblasenwassersucht). Probably due to pressure on developing eggs. Fiebiger, J. 1903.1.

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DISEASES OF GILLS AND SKIN

Most groups of parasites infest the gills and skin. See especially Crustacean parasites *under* Parasites.

See also Worm parasites, *of which those occurring in the gills and skin belong chiefly to the* Order Heterocotylea *of the* Class Trematoda.

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Fungus growths (Saprolegniacæ). *Causing Dermatomykosis (Pilzkrankheit). Chief forms are Saprolegnia and Achyla.*

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For fungi on fish eggs, see above under Diseases of eggs and fry.

Protozoan ectoparasites of gills and integument. *Occurring in both unless otherwise stated.*

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Ichthyophthirius cryptostomus of Leuciscus. Zacharias, E. O. 1892.2, 1893.3.

Amœba mucicola in gills of Labrus. Chatton, E. 1909.1.

Nosema anomalum, a myxosporidian encysting in skin of Gasterosteus. Stempell, W. 1904.1,.2.

Apiosoma piscicola, an infusorian in the skin. Blanchard, R. Add. 1885.1.

Henneguya acerinæ, a myxosporidian of the gills of Acerina. Schroeder, O. Add. 1906.1.

PECTORAL GIRDLE (*INCLUDING STERNUM*)

For related structures, *see* Pelvic Girdle, *and* Skeleton. *See also* Pectoral fins *under* Fins.

For the most important general treatise on the morphology of the pectoral girdle, see ★Wiedersheim, R. **1892.1.**

For a general account of the method of suspension of the pectoral girdle from the skull, with an extensive review of the literature, see ★Siebenrock, F. **1901.1.**

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Pectoral girdles of many Elasmobranchs elaborately figured. Garman, S. 1913.1.

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Anatomy of the parts of the pectoral girdle. —*Scapula of Siluroids.* Baudelot, E. 1868.1. —*Coracoid of Cottus.* Baudelot, E. 1868.8. —*Clavicle and cleithrum.* ★Gegenbaur, C. 1895.1; Sabatier, C. P. 1897.1. —*Supracleithralia.* Haller, B. Add. 1914.1.

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Sternum. *General considerations of the " sternum " in fishes, and belief of its independence of the costal sternum of the Amniotes.* Geoffroy-Saint-Hilaire, E. F. 1807.5, .8; Lavocat, A. 1889.1; Sabatier, C. P. 1897.1, 1902.1.

Presence in the shark Hexanchus (Notidanus), of a pre-sternum derived from the ends of the coracoidal portions of the continuous pectoral girdle. Haswell, W. A. 1885.2; Parker, T. J. 1890.2, 1891.1; White, P. J. 1895.1,.2.

In the carp (Cyprinus) there is a pseudosternum, composed of connective tissue and elastic elements attached to the ends of the *ribs and joined mesially.* Baehr, W. B. 1906.1.

For a recent detailed study of the phylogeny of the sternum in vertebrates including fishes, combining the coracoidal and costal views by considering the association with ribs as a secondary condition, see ★Hanson, F. B. *in* Amer. Journ. Anat., 1919–20, vol. 26, pp. 41–117.

PELAGIC FISHES

For a general treatise on "Oceanic ichthyology" with descriptions of the "pelagic fishes of the world," see ★Goode, G. B. & Bean, T. H. **1896.1.**

Geographical distribution, relation of pelagic fishes to deep-sea forms, etc. Chun, C. 1886.1–1890.1.

Adaptations of sailfishes for pelagic life. Dollo, L. 1909.5.

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For papers on pelagic ova and pelagic larval stages, see under Planktonic fauna.

PELVIC GIRDLE (*PELVIS*)

For related structures, see Pectoral Girdle, *and see under* Skeleton. *See also* Pelvic fins *under* Fins.

For an outstanding general treatise on the morphology of the pelvic girdle, see ★Wiedersheim, R. **1892.1.**

Development, evolution and phylogeny of the pelvic girdle. Paramore, R. H. 1910.1; Kehrer, F. A. 1896.1; Wiedersheim, R. E. 1888.1, 1889.1, 1890.1.

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PHYSIOLOGY

For the physiology or functions of particular organs, reference should be made to those organs, such as Heart; Liver; Nervous system; Thymus; Thyroid; Suprarenal organs; Urogenital system; etc.

Additional topics of interest are Chemistry; Digestion; Respiration; Smell; Taste; Vision; etc.

For the maintenance of equilibrium, *see* Hearing and the Static Sense.

General treatises, text-books, etc. *Text in English.* — Agassiz, J. L., & Gould, A. A. 1848.1; Todd, R. B. 1859.1; Schäfer, E. A. Add. 1898.1. — *Text in French.* Bert, P. 1870.1; Chatin, J. 1880.1; Dubois, R. 1898.1; Edwards, H. M. 1857.1. — *Text in German.* Rudolphi, C. A. 1821.1; Bergmann, C., & Leuckart, C. G. Add. 1855.1; Pütter, A. Add. 1911.1; ★Winterstein, H. Add. 1911.1. — *Text in Italian.* Doria, G., Ferrari, S., & Lessona, M. 1861.1–1869.1.

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Exchange of pigments in ovary and muscle of salmon. Newbigin, M. I. 1900.1.

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Influence in development. Brown, O. H. 1905.1; Loeb, J. 1911.2, 1912.3; McClendon, J. F. 1913.1, 1914.2; Nordqvist, O. F. 1898.4; Philippson, M. 1912.1; Scott, G. G., & Denis, W. 1913.1; Stockard, C. R. 1907.4; Strodtmann, S. 1915.1.

For experimental variation of osmotic pressure by use of salt and sugar solutions, see below.

Physiology — *Cont'd.*

Effects of changes in density and salinity of water, accompanying passage of freshwater fishes to salt water and vice versa.

Miscellanea. Adam, G. 1898.1; Chaper, M. 1883.1; Schmidt-Nielsen, S. 1909.1; Tona, A. 1908.1; Anon. 497.

Physiological effects, chiefly effects upon the blood. Drzewina, A. 1906.1, 1908.1; Gautrelet, J. 1905.1 (*Review of Quinton*); Mosso, A. 1891.1; Quinton, R. 1904.2, 1905.2; Scott, G. G. 1910.1, 1911.1, 1913.2, .3, 1914.2; ★Sumner, F. B. 1905.2,.3, 1906.1,.2, 1907.2.

Fishes which can live in both salt and freshwater. Mather, F. 1882.1; Valenciennes, A. 1841.1.

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Marine fishes in fresh-water; adaptability, migrations, etc. Adam, G. 1898.1; Arnold, J. B. 1830.1; Baird, S. F. 1873.8; Blanchet, M. 1914.1; Davies, J. H. 1829.1; Day, F. 1880.14; Findeis, G. 1909.1; Gogorza, J. 1891.1; Hintze, A. 1887.1; Jammes, L. 1902.1; Jerdon, T. C. 1866.1; Kammerer, P. 1909.1; McCulloch, A. R. 1915.1 (*Galaxias, migrations*); MacCulloch, J. 1824.1, 1826.1; Nardo, G. D. 1865.1; Nazarov, J. 1901.1 (*Acipenser, migrations*); Ramsay, E. P. 1874.1; Robertson, P. A. 1907.1 (*Atherina rissoi reared in freshwater*); Schmidt-Nielsen, S. 1910.1; Vaney, C., & Conte, A. 1902.1.

Fundulus in fresh-water. Murdoch, J. 1912.1; Smith, Eugene. 1912.1; Sumner, F. B. 1911.3.

Syngnathus in Ganges. Buchanan, F. 1822.1.

Sharks in fresh-water. Harting, P. 1876.6. — *in rivers of Borneo.* Beccari, O. Add. 1904.1; St. John, S. Add. 1844.1. — *Squatina.* Barty, T. 1884.1. — *Acanthias in Denmark.* Feddersen, A. F. 1880.2. — *Eulamia in Lake Nicaragua.* Gill, T. N. 1893.4; Lütken, C. F. 1880.2; Smith, H. M. 1893.5. — *Selache in Loch Broom.* Workman, W. H. 1906.1. — *Blue shark in Firth of Forth.* Evans, W. Add. 1898.1.

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Fresh-water fishes in salt-water. Bade, E. 1906.1; Cornish, T. 1866.2; Harting, P. 1877.4; Kammerer, P. 1907.8; Neudörfer, A. 1907.1; Portier, P. 1914.1; Anon. 182.

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Attempted hatching of salmon ova in salt-water. Nordqvist, O. F. 1898.4.

PHYSIOLOGICAL RESEARCHES

Chiefly laboratory experiments based on fish material

For the artificial production of Cyclopia and other monstrosities, *see under* Teratology.

For Experimental embryology, *see under* Embryology.

For Galvanotaxis, Phototaxis, Rheotaxis, etc., *see under* Behavior.

For the effects of injection of foreign blood sera, including the toxic effects of eel-serum, *see* Blood serum *under* Blood.

For the effects of heat and cold, *see* Temperature, effects.

For the effects upon coloration of the extirpation of the eyes, *see under* Coloration.

For experiments involving various parts of the Nervous System, their electrical stimulation or their section, *see under* Brain, Nervous System, *and* Spinal Cord.

For experimental researches on the action of the heart, *see under* Heart.

For poisons used in fishing, *see* Poisonous Plants *under* Fishing Methods.

For a general discussion (in German) of many physiological researches on fishes, with an excellent bibliography, see ★Baglioni, S. Add. **1910.1**.

Physiological effects of — Odor of hawthorn blossoms on various marine fishes. Parmentier, J. 1803.1. — *Dissolved gases, acidity, and alkalinity, and changes of temperature on the movements of marine fishes.* Shelford, V. E. & Powers, E. B. 1915.1.

Ambicoloration of flounder produced by reflection of light from mirror. Cunningham, J. T. 1891.3, 1893.10, 1895.1; Cunningham, J. T., & MacMunn, C. 1893.1.

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Effect upon cardiac activities. Hyde, I. H. 1908.1, 1909.1; Knight, A. P. 1897.1; Polimanti, O. 1911.1,.4.

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PISCICULTURE

For all topics relating to the practical aim or commercial utilization of fish-culture, *see* the section on Fisheries.

See also Diseases under Pathology; Parasites; and for care of ornamental fishes, *see* Aquaria, *and also* Aquarium Fishes.

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APPARATUS AND APPLIANCES

Including methods of use

Miscellanea

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For methods used in the handling of particular species, *see* Pisciculture by subjects, *below.*

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Regulation of temperature during hatching. Green, S. 1880.7; Schoch, G. 1892.2; Smith, H. M. 1904.6; Viguier, C. 1904.1.

"Russian" or dry method of fertilization. Reisenbichler, G. F. 1880.1, 1882.1; Stentzel, A. 1874.1; Stone, L. 1872.7; Anon. 574.

The Russian method which consists in the application of sperm to eggs without dilution, was originated by V. P. Vrasski in order to overcome the disadvantages of the very short life of spermatozoa after they have been placed in water. *For a further discussion of this subject, see* Duration of virility *under* Spermatozoa.

INTRODUCTION OF FISHES

throughout the world, with their occasional acclimatization

For the introduction of exotic species, purely as aquarium novelties, *see under* Aquaria, and under the various genera.

Various papers on the introduction and acclimatization of fishes. Chambers, W. O. 1883.1; Coste, J. J. 1874.1; Coste, P. 1854.1; D., H. D. 1879.1; Dagry, A. 1911.1; Gibbons, W. P. 1869.1; La Blanchère, P. R. 1874.3; Maitland, J. R. 1883.1, 1892.1; Mill, N. 1825.1; Noël de la Morinière, S. 1800.1; Smith, H. M. 1905.2.

Review of results in the Pacific States of the U. S. ★Smith, H. M. **1896.3.**

Methods of transportation of eggs and fishes

Eggs; *directions for transportation with methods of packing in wet moss, ice caps, dry-packing,* etc. Baird, S. F. 1879.9; Behr, S. 1882.1; Borne, M. 1880.5,.6, Add. 1882.1; Eckardt, R. 1879.2,.3,.5; Green, S. 1875.6; Haack, H. 1878.8; Hubbard, W. F. 1904.1; Huske, C. J. 1884.2. Lindon, E. V. 1869.1; Mather, F. 1891.2; Millet, C. 1855.3; Page, W. F. 1887.1; ★Titcomb, J. W. 1910.1; ★Anon. 574.

Pisciculture — *Cont'd.*

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Details of fittings of R. M. S. "Oroya" used in transport of plaice from England to Australia. ★Dannevig, H. C. 1902.2.

Introduction of Bass and Sunfish

Black bass. (*Chiefly large-mouthed, from U. S. Fish Comm.*) *Introduction into England.* Arielson, – 1872.1; Goode, G. B. 1883.17; Hensman, J. T. 1884.1 (*Nene R.*); Silk, M. 1880.1. — *into Finland.* Nordqvist, O. Add. 1894.1. — *into France.* D'Arenberg, P. 1911.1. — *into Germany.* Borne, M. 1883.1,.2, 1884.2,.3, 1886.1, Add. 1882.1; Surbeck, G. 1905.2. — *into Balaton lake, Hungary.* Vutskits, G. 1910.1,.2. — *into Italy.* Besana, G. 1908.1; Supino, F. 1912.2. — *into Sweden.* Hintze, A. 1888.1,1893.3. — *into the Philippine Is.* Seale, A. 1910.3.

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Lepomis megalotis in France. Bouvet, G. 1900.1; Olivier, E. 1901.2. — *Lepomis auritus in Italy.* Bellotti, C., Ronchetti, – & others. 1905.1; Besana, G. 1908.1; Natoli, R. 1905.1.

Introduction of Carp

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Introduction of Catfish

American catfish (three species) introduced into California in 1874, by L. Stone. Smith, H. M. 1896.3. — *Catfish from Potomac put in Colorado R., Arizona, 1884.* McDonald, M. 1884.12.

American bullhead or horned pout (Ameiurus nebulosus), sent in 1885 to England, France, Germany and Netherlands. Smiley, C. W. 1885.4. — *Ameiurus, proposed introduction into Belgium.* Lefebre, A. 1883.1; Willequet, E. 1883.1,.2; Wilson, T. 1882.1. — *Ameiurus introduced into France.* Bellesme, J. 1886.1; Chappellier, A. 1907.1; Fuhrmann, O. 1903.2, 1905.2; Künstler, J. 1907.1, 1908.1; Lavauden, L. 1905.1; Lavollée, G. 1906.1; Letacq, A. L. 1906.1, 1909.1,.2; Meugnot, A. 1908.2; Pion-Gaud, P. 1904.1; Pion-Gaud, P. & Lavauden, L. 1904.1; Robertson-Proschowski, A. 1904.1; Rollinat, R. 1910.1. — *into Germany.* Borne, M. 1891.1. — *into Italy.* Mazzarelli, G. F. 1909.2; Meschinelli, L. 1907.1. — *into New Zealand.* Ayson, L. F. 1908.1.

European catfish (Silurus glanis) introduced into England. Sachs, T. R. 1880.1; Stricker, W. 1869.1; Anon. 395. — *into France,* Valenciennes, A. 1851.1,.2, 1855.1.

Introduction of Gourami

Gourami (Osphromenus olfax), introduction into various countries. ★Gill, T. N. 1874.3; Rufz de Lavison, E. 1861.1; Anon. 535. — *into France.* Baird, S. F. 1871.22, 1875.19; Barthélemy-Lapommeraye, – 1863.5, 1865.1; Carbonnier, P. 1869.1,.2; Coste, P. 1865.1; Dabry de Thiersant, P. 1868.1; Vinson, A. 1861.1; Anon. 408; Sicard, A. Add. 1872.1; Saulcy, E. Add. 1861.1. — *into Algeria.* Vinson, A. 1861.1. — *into Ceylon.* Pert-

wee, A. H. 1911.1. — *Acclimatization in Reunion Islands.* Vinson, A. 1861.1. — *Introduction (proposed) in Italy.* Doderlein, P. Add. 1867.1. — *Introduction into Japan.* Tanaka, S. & Yoshinaga, T. Add. 1914.1.

Introduction of Salmon and Trout

Brook trout. *American,* (*Salvelinus fontinalis*). *Introduction into California, of trout from New Hampshire.* Bean, T. H. 1911.6. — *introduced in Austria.* Franke, J. 1908.1; Pirko, F. 1908.1. — *in England.* Chambers, W. O. 1889.1; Anon. 40. — *in Finland.* Nordqvist, O. F. 1899.12. — *in Germany.* Behr, S. 1883.1; Borne, M. 1879.2, 1885.1; Haack, H. 1880.4,.9. — *in Sweden.* Hammarström, C. 1901.1; Lönnberg, A. J. 1905.1,.2,.8. — (*recommended*) *for Switzerland.* Goll, H. 1887.1. — *in Tasmania.* Seager, P. S. 1888.1.

California or Quinnat salmon. (*Ova*), *sent to South Africa.* Baird, S. F. 1876.24.

Attempts at introduction in waters of eastern North America. Baird, S. F. 1873.31; Slack, J. H. 1876.1; Webber, S. 1878.2. — *in New York.* Baird, S. F. 1874.13. — *in Sunapee Lake, N. H.* Evermann, B. W. 1906.12, 1907.3; Kendall, W. C. 1914.1, *also in* ★Rept. U. S. Fish Comm., 1912. (1914) — *in Lake Geneva, Wis.* Fairbank, N. K. 1880.3, 1881.1. — *into Mississippi R. near Memphis.* McDowell, W. W. 1878.1; Will, 1879.1. — *in New Jersey.* Peirce, M. P. 1877.2. — *in Lake Ontario.* Robson, J. J. 1878.1; Smith, H. M. 1899.1; Wilmot, S. 1882.1,.2. — *in Susquehanna R., Pa.* Clapp, A. F. 1893.1; Worral, J. 1873.1. — *in Great Salt Lake, Utah.* Rockwood, A. P. 1876.1. — *in Louisiana.* Bean, T. H. Add. 1882.1.

Introduction into Chile, S. A. Albert, F. 1902.1, 1906.1, 1907.1; Cerda, J. 1885.1; Sage, C. 1912.1; Smith, W. A. 1897.2.

Attempts at introduction into Europe. — *in Austria, Galicia.* Nowicki, M. 1880.3. — *in British Isles.* Baird, S. F. 1879.7; Mather, F. 1879.1, 1880.4. — *in France.* Baird, S. F. 1879.7; Daguin, – 1893.1 (*Haute-Marne R.*); Fage, L. 1912.1,.2 (*recommended for Mediterranean rivers*); Jousset de B., G. 1897.2, Add. 1891.1; Marion, A. F. & Guitel, F. 1890.1; Maslieurat-Lagémard, – 1884.1; Mather, F. 1879.1, 1880.4; Raveret-Wattel, C. 1880.1,.2; Valèry-Mayet, – 1884.1, 1885.1; Berthoule, A. Add. 1889.1. — *in Germany.* Baird, S. F. 1879.7; Eckhardt, R. 1879.1; Haack, H. 1878.3,.4, 1879.4; Jaffé, S. 1896.1; Mather, F. 1879.1, 1880.4; Anon. 73. — *into Lake Castel Gandolfo, Italy.* Vinciguerra, D. 1893.3, 1896.2; *Failure of introduction in Italy.* Besana, G. 1908.1. — *in Netherlands.* Baird, S. F. 1879.7; Bottemanne, C. J. 1880.1; Hegt, J. N. 1880.1; Mather, F. 1879.1, 1880.4.

Introduction into Australia. Baird, S. F. 1873.4, 1876.25; Philips, B. 1874.3; ★Wilson, S. 1878.1, **1879.1.**

Introduction into New Zealand. Baird, S. F. 1873.47, 1876.23; Howard, H. 1876.1; ★Nicols, A. **1882.1** (*Gen. treat.*); Rutherfurd, A. J. 1901.1; Stewart, J. 1876.1; Vion, R. 1879.1; Anon. 68; Farr, S. C. Add. 1883.1. — *For correspondence relating to transmission of eggs of Quinnat salmon to New Zealand, 1875 to 1878, see* Rept. U. S. Fish Comm., 1875–76 (1878), IV, 959–1003, *and* 1878 (1880), VI, 825–905.

Other American salmonids introduced. *Steelhead trout* (*Salmo gairdneri*), *acclimated in Great Lakes.* Bean, B. A. 1902.3; Evermann, B. W. 1907.6; Smith, H. M. 1899.1.

Silver or Coho salmon (*Oncorhynchus kisutch*) *planted in Maine.* Evermann, B. W. 1905.4.

Sending of Salmo mykiss macdonaldi from Colorado to Germany. Jaffé, S. 1902.1; Persico, P. 1903.1.

Lake Tahoe trout (*Salmo henshawi*), *details of original distribution in Sierra Nevada of California as altered by man.* Jordan, D. S. 1901.5, 1904.5.

Atlantic salmon (*Salmo salar*). *First introduction of ova from New Brunswick to New England, 1866.* Edmunds, M. C. 1873.1. — *Various plantings in waters of New Jersey and New York.* Bean, T. H. 1890.28; Mather, F. 1884.3, 1889.4, 1890.1; Norris, T. 1872.1, 1874.6; Slack, J. H. 1874.2; Ward, F. M. 1887.1. — *in Wisconsin.* Douseman, H. F. 1874.1. — *in New Hampshire.* Fletcher, W. W. 1874.1. — *introduced on Pacific coast.* Smith, H. M. 1896.3.

Landlocked salmon put into Woodhull lake, N. Y. Green, S. 1882.2. — *sent to Argentina.* Tulian, E. A. 1910.1, Add. 1911.1.

European salmon. *Rhine salmon planted in Lake Geneva.* Chavannes, A. 1869.1,.2, 1870.1; Figuier, G. L. 1858.1 (vi). — *in Ticino R., Italy.* Pavesi, P. 1886.1. — *in the Danube.* Anon. 75. — *sent to the U. S., 1872.* Baird, S. F. 1874.27; Goode, G. B. 1881.2.

Danube salmon ova (*Salmo hucho*), *sent to America.* Hessel, R. 1874.2.

Salmon (*S. salar*) *introduced in Mediterranean rivers of France.* Gervais, F. L. 1861.1, 1862.1. — *Possibility of acclimating in Marne.* Roger Desgenettes, – 1863.1.

Salmon ova (*S. salar*) *from England and Scotland taken to Australia.* Johnson, T. 1864.1, 1865.1; Ramel, P. 1864.1; Siebold, C. T. 1869.1; Watts, H. E. 1868.1; Anon. 21, 486.

Numerous attempts beginning in 1864 to acclimate English salmon in Tasmania. ★Allport, M. 1864.1–1878.1; Dannevig, G. M. 1885.3; Günther, A. C. 1872.11; Johnston, R. M. 1888.1; Kent, W. S. 1887.1; ★Nicols, A. **1882.1;** Piguenit, W. C. 1867.1; ★Seager, P. S. **1888.1,** (*History*); Soubeiran, J. L. 1870.1,.4; Anon. 19, 485; Brady, T. Add. 1888.1.

Pisciculture — *Cont'd.*
— *in New Zealand.* Ayson, L. F. 1908.1; Anon. 20.

European trout. (*Brown trout, Loch Leven trout, and Sea trout are now considered one species, Salmo trutta.*)

Trout introduced into Cape Colony, Africa. Raveret-Wattel, C. 1903.1, 1904.2. — *into Natal, Africa.* Feilden, H. W. Add. 1893.1. — *into the U. S.* McDonald, M. 1887.10; Marston, R. B. 1896.1; Mather, F. 1889.1; Smiley, C. W. 1889.1; — *in California.* Jordan, D. S. 1905.2. — *into India.* Day, F. 1876.4; Smythies, E. A. 1910.1. — *into Tasmania.* Allport, M. 1866.1, 1869.5, 1870.1,.2,.3, 1871.1; Seager, P. S. 1888.1; Anon. 21. — *into New Zealand.* Arthur, W. 1879.1, 1883.5, 1884.3; Anon. 544. — *Where to catch trout in New Zealand.* Spackman, W. H. 1892.1. — *Native fish causing disappearance.* Ferguson, A. Add. 1889.1.

Lake trout. *American,* (*Cristivomer namaycush*). *Introduced in Argentina, S. A.* Tulian, E. A. 1910.1. — *in England.* Fennell, H. 1885.1. — *in France.* Banmeyer, – 1884.1. — *in Switzerland.* Delachaux, T. 1895.1.

Rainbow trout. *American,* (*Salmo irideus*). *Introduction in Austria.* Pirko, F. 1908.1; Salomon, K. 1906.1. — *in England.* Chambers, W. O. 1889.1; Fennell, H. 1885.1. — *in Finland.* Nordqvist, O. F. 1895.7, 1896.8. — *in France.* Audeville, A. 1888.1; Cligny, A. 1912.3; Lefebre, A. 1896.1; Letacq, A. L. 1900.1; Marcillac, A. 1896.1–1900.1; Mocquard, F. 1911.1; Oltramare, H. 1897.1,.2. — *in Germany.* Arens, C. 1898.1, 1906.2; Borne, M. 1885.1; Coester, O. 1907.1; Herrmann, W. 1907.1; Hofer, B. 1907.1; Pressel, W. 1906.1, Add. 1900.1; Sieglin, H. 1892.1, 1905.1; Musseleck, G. Add. 1902.1. — *in Italy.* Besana, G. 1908.1; Cecconi, G. 1904.1. — *in Sweden.* Hammarström, C. 1901.1; Hintze, A. 1895.1; Lönnberg, A. J. 1905.1,.2,.8. — *in Switzerland.* Surbeck, G. 1913.2. — *in Japan.* Akekio, S. 1882.1; Kishinouye, K. 1904.1. — *in New Zealand.* Ayson, L. F. 1908.1.

Introduction in waters of eastern United States: Michigan. Bower, S. 1910.1; Clark, F. N. 1883.4; Metcalf, M. 1883.1. — *Missouri.* Maynard, H. J. 1889.1. — *New Hampshire.* Johnson, F. M. 1905.1. — *New York.* Bean, T. H. 1896.2; Farnum, C. A. 1879.1; Green, S. 1878.1,.2, 1879.1; Long, W. 1879.1.

Saibling. *Charr or "Ombre Chevalier" of Alpine Lakes* (*Salvelinus alpinus*). *Introduced in Chile, S. A.* Albert, F. 1902.1, 1906.1, 1907.1; — *in France.* Rico, B. 1877.1. — *in Italy.* Filipi, F. 1861.2. — *in New Zealand and Tasmania.* Siebold, C. T. 1868.1, 1869.1; Anon. 21, 22.

Introduction of Shad

American or common shad; successful acclimatization in California. First fry planted in Sacramento R. by Seth Green, in 1871. Baird, S. F. 1873.37,.40, 1876.5, 1880.6; Lang, W. 1879.2; Mather, F. 1878.1; Milner, J. W. 1874.4; Porter, B. B. 1878.3; ★Smith, H. M. 1893.1, 1896.3; Throckmorton, S. R. 1873.1,.2, 1874.2; Anon. 305. — *Second lot transferred from Hudson to Sacramento, in 1873.* Stone, L. 1874.3,.9.

Introduction into Oregon. Finely, C. I. 1884.1.

Shad planted by U. S. Fish Comm. in Ohio and Mississippi Rivers. Baird, S. F. 1873.2,.38, 1876.27, 1877.1; Clift, M. 1874.1; Green, S. 1874.8; Philips, B. 1874.9; Smiley, C. W. 1883.7.

Introduction of American shad into Germany. Finsch, F. H. 1876.1; Wengen, – 1877.2.

Introduction of striped bass in California

Accounts of first planting of young in San Francisco Bay, in 1879. Baird, S. F. 1880.6; Mason, H. W. 1882.1; Stone, L. 1882.3; Throckmorton, S. R. 1882.2. —*Review of the successful acclimatization.* ★Smith, H. M. 1893.1.

Introduction of Whitefish

European whitefish. *Madue Marœne* (*Coregonus marœna*) *brought from Germany and placed in Gardner's Lake, Michigan, in 1877.* Baird, S. F. 1878.7, 1879.10 Goode, G. B. 1881.2.

Marœne (*C. marœna*) *from northern Germany, introduced in lakes of Bavaria, etc.* Haack, H. 1878.1, 1879.7; Hofer, B. 1905.1; Surbeck, G. 1905.4, 1907.1.

Blaufelchen (*C. wartmanni*) *introduced in Italy.* Besana, G. 1897.1; Filippi, F. 1861.2; Pavesi, P. 1886.1; Vinciguerra, D. 1895.1.

American whitefish. *Eggs shipped from Clarkston, Michigan, to California in 1872* (*Unsuccessful results*). Goode, G. B. 1881.2; Milner, J. W. 1874.4; Stone, L. 1874.3; Smith, H. M. 1896.3.

Introduction in France. Banmeyer, – 1884.1. — *in England.* Fennell, H. 1885.1. — *in Germany, Bavaria.* Borne, M. 1885.1. — *in Switzerland.* Frey, E. 1885.1; Mason, F. H. 1883.1.

Transmission of eggs to Australia and New Zealand. Baird, S. F. 1879.10; Greenfield, A. 1884.1; Whitcombe, W. P. 1885.1. —*For correspondence relating to this transmission in 1875–1878, see* Rept. U. S. Fish Comm. 1875–76 (1878), IV. 959–1003, *and* 1878 (1880), VI, 825–905.

Various fishes introduced

Australian bass (*Percalates fluviatilis*) *taken from New South Wales to Fiji.* Stead, D. G. 1914.1.

Barbus in Sig River, Algeria. Naudin, A. 1907.1; Raveret-Wattel, C. 1913.1.

Burbot in Lake Geneva, Switzerland. Forel, F. A. 1900.2.

Carp sucker in New South Wales. Bean, T. H. 1889.8.

Grayling in waters of eastern United States. Norris, T. 1876.1.

Mullet (Jamaican) proposed for United States. Bean, T. H. 1890.26, 1891.17. — *Mullet (Hawaiian) proposed for U. S.* Miller, J. F. 1884.1.

Orfe (Idus) in England. Raveret-Wattel, C. 1874.1; Anon. 306.

Perch (Yellow perch) introduced in California. Smith, H. M. 1896.3; Stone, L. 1874.4. — *Introduction (proposed in North Dakota).* Pope, T. E. 1908.1.

Plaice transferred from Barents Sea to North Sea. Atkinson, G. T. 1909.1, 1910.1. — *Transplantation of inshore plaice to Dogger Bank.* Borley, J. O. 1912.2. — *Plaice and sole from England introduced in Australian waters.* Dannevig, H. C. 1902.2. — *Plaice introduced into Plöner sea.* Duncker, G. 1894.1.

Sander or Pike-perch (Lucioperca sandra) of Germany introduced in England. Dallmer, E. 1879.3; Sachs, T. R. 1880.1. — *in France.* Valenciennes, A. 1851.1. — *in Norway.* Huitsfeldt-Kaas, H. 1906.1.

Sole, attempted introduction in American waters. Baird, S. F. 1884.1 (p. liv); Goode, G. B. 1880.19; Mather, F. 1878.3, 1879.2; Moore, T. J. Add. 1889.1.

Tench introduced in Algeria. Cosson, E. S. 1862.1. — *in Chile.* Albert, F. 1906.1. — *in India.* Day, F. 1876.4. — *in Sweden.* Trybom, F. 1887.3.

Top-minnows (Pœciliidæ) for mosquito destruction. Gambusia affinis introduced in Hawaiian Is. Seale, A. 1905.1; Van Dine, D. L. 1900.1. — *in Philippines.* Seale, A. *in* Philippine Journ. Sci., 1917, XII, Sect. D, p. 177–187. — *Lebistes reticulatus in Cape Colony, Africa.* Gilchrist, J. D. 1913.2.

Proposed introduction of the " Pejerey " (Atherinichthys bonariensis) of Argentina into France. Iches, L. 1910.1.

NOXIOUS ORGANISMS

For organisms parasitic upon fishes, *see under* Parasites. *For* the voracity of fishes such as sharks, caribe, etc., and accounts of attacks upon men, *see* Predatory fishes.

Fish-eating plants

Delachaux, T. 1894.1; Halpérine, E. 1885.1; Walter, E. 1894.1. — *Bidnes cernua.* Lorenz, O. 1880.1.

Bladderwort (Utricularia) catching young fishes. Dean, B. 1889.1; Forbes, S. A. 1884.2; Moseley, H. N. 1884.1; Simms, G. E. 1884.1; Harting, J. E. Add. 1906.1.

Piscivorous animals

Miscellaneous papers on fish enemies. Allport, M. 1864.4; Ambrose, J. 1890.1; Annin, J. 1882.1, Add. 1884.1; Benecke, B. 1886.3; Hintze, A. 1900.1; Hofmann, E. 1884.1; Keene, J. H. 1877.1; La Valette St. George, A. 1879.2, 1880.1; Lindes, L. 1880.10; McGovern, H. D. 1880.1; Meyer, J. 1881.1; Mortensen, O. T. 1896.1; Pfyffer, L. 1885.1; Prince, E. E. 1914.2; Reuss, H. 1906.2; Löwe, – Pre-Linn. 1718.1.

Means of capture or destruction. Borne, M. 1880.1; Claparède, A. 1885.1; Pieper, A. 1878.1; Walter, E. [n. d.]. — *Destroying leeches.* Plehn, M. Add. 1898.1. — *Copper sulphate for destroying obnoxious fishes.* Titcombe, J. W. Add. 1914.1.

Invertebrates. Milner, J. W. 1877.2. — *Leeches.* Baster, J. 1762.2; Mokày, T. 1904.1; Verrill, A. E. 1874.2. — *Hydra destroying trout fry.* Beardsley, A. E. 1904.1; Schuberg, A. 1905.1. — *Fish-eating corals of Galapagos.* Jenyns, L. 1842.1. — *Snails.* K. – 1861.1. — *Actiniæ, power of killing their prey.* Macdonnell, R. 1857.1, .2. — *Whelks, means of combating.* Petersen, C. 1911.1. — *Shrimps.* Corvinus, G. L. Pre-Linn. 1715.1.

Spiders killing fish. Peters, T. M. 1876.1; Spring, E. A. 1860.1.

For a popular article, containing reprints of all the original accounts (5 in number) of spiders killing fish, see E. W. Gudger *in* Natural History (Journ. Amer. Mus.) 1922, vol. 22, pp. 565–568.

Insects. Raveret-Wattel, C. 1889.1, 1892.2; Richardson, R. Pre-Linn. 1734.1. — *Bugs. (Belostomidæ.)* Dimmock, G. 1886.1; Putnam, F. W. Add. 1888.1. — *Mosquitoes.* Murray, C. H. 1885.1. — *Beetles.* Riley, C. V. 1885.1; Kulmus, J. Pre-Linn. 1719.1. — *Fly larvæ.* Schuberg, A. 1914.1. — *Corixa ovivora (Hemipteron) destroying fish ova in India.* Thomas, H. S. 1871.1.

Fishes. *As destructive to other fishes.* Keene, J. H. 1879.1; McIntosh, W. C. 1902.1; Anon. 554. — *Gar-pike.* Caldwell, E. E. 1913.1; Hussakof, L. 1914.1. — *Dogfish. (Marine.)* Collins, J. W. 1884.3; Warren, R. 1882.1; Prince, E. E. Add. 1904.1. — *Haddock feeding on eggs of herring.* Duge, F. 1903.1. — *Carp.* Gurney, J. H. 1860.1; Ryder, J. A. 1884.2. — *Pickerel.* E., W. W. 1874.1. — *Bass.* G., – von. 1877.1. — *Lampreys.* Gage, S. H. 1894.1, 1898.1, 1899.1; Robertson, D. 1875.1; Anon. 612. — *Goldfish.* Green, S. 1878.8. — *Plecoglossus injuring other fishes.* Kishinouye, K. 1895.2. — *Roccus lineatus feeding on menhaden.* Mosher, G. 1883.1. — *Methods of extermination.* Prince, E. E. Add. 1905.2.

Amphibians and reptiles. *Snakes catching fish.* Annin, J. 1882.1; Hessel, R. 1884.2; Malmer, H. 1895.1; Sterling, E. 1880.2; Warner, J. S. 1884.1; Nye, W. Add. 1883.1. — *Cryptobranchus destructive to spawn.* Clarke, G. 1873.1. — *Toads destroying fishes.* Duchemin, E. 1870.1, .2, .3; Förster, C. 1873.1; Jenkins, C. 1870.1; Lankester, E. R. 1870.1. — *Reptiles.* Rollinat, R. 1902.1. — *Crocodiles.* Woods, J. E. 1881.1.

Birds. McIntosh, W. C. 1903.2; Schalin, Z. 1883.1; Warren, B. H. 1897.1; Rhead, L. Add. 1908.1. — *King-fisher.* Annin, J. 1882.1; Nichols, J. T. 1915.5; Plocq, E. 1907.1. — *Swans destroying spawn.* Bambridge, B. R. 1879.1; Plummer, R. 1879.1; Forel, A. H. Add. 1900.1. — *Water-ouzel.* Horsfall, J. H. 1863.1;

Pisciculture – *Cont'd.*

Clutterbuck, J. W. Add. 1863.1. —*Grebes.* Maurer, – 1895.1; Trybom, F. 1902.1,.2. —*Gulls.* Maurer, – 1895.1; Poncy, R. 1911.1. —*Cormorant.* Panchaud, E. 1911.1; Poncy, R. 1911.2. —*Osprey.* Schlegel, H. & Müller, S. 1839.2. —*Grackle.* Elliott, H. W. Add. 1890.1. —*Ducks.* Killinger, A. Add. 1913.1. —*Bee-eaters as fish-eaters.* Reeves, E. G., Willey, A. & Green, E. E. Add. 1910.1.

Mammals. Annin, J. 1882.1; Warren, B. H. 1897.1. —*Shrew.* Brehm, C. L. 1830.1. —*Weasel.* Delachaux, T. 1895.2. —*Skunk.* Mesmer-Weber, J. 1895.1. —*Otter,* Puenzieux, A. 1894.1. —*Muskrat.* Carpenter, C. Add. 1884.1; Elliott, H. W. Add. 1884.1; Merriam, C. H. Add. 1884.1. —*Bats eating fishes.* Harting, J. E. Add. 1906.1. —*Seals injuring Baltic fisheries.* Hinkelmann, — Add. 1887.1.

POND CULTURE

See also *below* under Bass, Carp, Trout and similar fishes which are ordinarily reared in ponds.

General treatises. *Rearing of fishes in ponds, with methods, proper fishes, construction of ponds, etc.*

Text in English. Albin, E. 1794.1; Boccius, G. 1841.1, 1848.1; Buckland, F. T. 1881.1; Hoare, J. 1870.2; ★Meehan, W. E. 1913.1; ★Townsend, C. H. 1906.1.

Text in French. Dubois, L. 1824.1; Leblanc, – 1787.1; Puvis, A. 1844.1; ★Raveret-Wattel, C. **1904.1**; Rougier de la Bergerie, – 1819.1.

Text in German. Ackerhof, A. D. 1869.1; Benecke, B. 1886.5, 1889.1; Berisch, C. L. 1794.1; Biermann, A. 1865.1; Biesenbach, R. 1897.1; ★Borne, M. 1891.2, 1895.2, 1897.1, 1904.1; Cancrin, F. L. 1791.1; Debschitz, H. 1901.3; Delius, A. 1874.1; Hermann, C. G. 1795.1; Hömberg, W. 1902.1; Neu, J. F. 1859.1; ★Nicklas, C. **1881.1,** 1898.1; Schinke, K. 1902.1; Schroeder, E. A. 1889.1; Stölter, G. F. 1859.1, 1860.1; ★Vogel, P. 1898.1, 1909.1; Wagner, G. J. 1762.1, 1785.1; Weber, F. E. 1901.1; Riemann, J. F. Add. 1798.1; ★Taurke, F. Add. 1908.1.

Text respectively in Swedish and Russian. Lindstedt, P. 1911.1; Sikorskij, V. L. 1905.1.

Aquatic plants for ponds. *Value, proper kinds, etc.* Brakeley, J. H. 1884.1; Green, C. K. 1905.1; Guerne, J. 1897.1; Lamiral, E. 1851.1; Leonhardt, E. E. 1904.11; Schiemenz, P. 1905.1; Schikora, F. 1899.1; Ward, L. F. 1883.1,.2; Titcombe, J. W. Add. 1909.1. —*Protecting shores by planting reeds, cane, etc.* Müller, – 1877.2. —*Treatment for removal of algæ.* Robinson, R. K. 1910.1.

Miscellaneous: *Papers on pond culture methods, construction, etc.*

Text in English. Baird, S. F. 1873.7,.49; Bean, T. H. 1897.1; Dyche, L. L. 1914.2; Evermann, B. W. 1906.9; Lauman, F. A. 1910.1; Leary, J. L. 1905.1; Marshall, C. 1800.1–1805.1; Miller, P. 1810.1; Mordant, J. 1761.1; North, R. 1794.1, 1835.1; Townsend, C. H. 1914.1, Add. 1913.7; Worth, S. G. 1884.1; Anon. 239; Buck, W. O. Add. 1914.1; Leary, J. L. Add. 1905.1; Mather, F. Add. 1900.1. —*Device for improving water circulation.* Stead, D. G. 1914.2.

Text in German. Arens, C. 1896.1; Dyhrn, E. 1782.1; Gerhardt, P. 1904.1; Haempel, O. 1912.2; Haldenwang, A. 1880.2; Janke, H. 1878.1; Kuhnert, R. 1909.1; Leuchs, J. C. 1862.1; Neresheimer, E. 1911.4; Schneider, G. 1910.4; Anon. 549; Cancrin, F. L. Add. 1791.1; Herrmann, M. C. G. Add. 1791.1; Radermacher, D. Add. 1773.1; Tiburtius, T. Add. 1758.1. — Add. 1775.1.

Early works *on the construction and care of fish ponds. References to be found in* Pre-Linn. *section.*

Early general treatises, books, etc. Chauffour, J. 1618.1; Conringius, H. 1671.1; Crescentiis, P. 1548.1; Dubravius, J. 1547.1, 1599.1; Estienne, C. 1554.1; Hagen, J. L. 1727.1; Hale, T. 1756.1; Heresbach, C. 1750.1; Jacob, G. 1717.1; North, R. 1713.1; Wagner, G. J. 1729.1.

Miscellaneous early papers on ponds and pond culture. Abbondio, G. 1715.1; Cato, M. P. 1581.1; D., L. B. 1717.1; Flemming, H. F. 1724.1; Heger, J. 1727.1; Palladius, R. T. 1543.1; Seger, J. L. 1727.1; Serres, O. 1600.1; Steinbock, E. F. 1730.1; Taverner, J. 1600.1; Thiemen, J. C. 1682.1; Tiburtius, T. 1757.1; Werlosching, J. B. 1750.1.

Pisciculture by subjects

For descriptions of the methods employed in magnitude by the U. S. Bureau of Fisheries, the reader should consult "*A manual of fish-culture.*" ★Anon. 574, *Revised edition,* Doc. 345, 1900. *See also* ★Titcomb, J. W. **1910.1.**

Anchovy culture

In the Netherlands. Hoek, P. 1891.2; Hoek, P. & others. 1886.1; Redeke, H. C. 1913.1, 1914.1.

Black Bass culture

Comprising both large mouth and small mouth black bass.

General discussion of methods in bass culture. Lydell, D. 1904.1; ★Page, W. F. 1894.2; Titcomb, J. W. 1910.1; ★Anon. 574.

Special topics: Experiments in artificial fertilization. Bower, S. 1897.1. —*Artificial bass nest.* Fuller, A. E. 1908.1. —*Plan for bass ponds.* Lambert, E. M. 1905.1. —*Assorting fry to prevent cannibalism.* Stranahan, J. J. 1907.1, 1909.1. —*Feeding young bass.* Carter, E. N. Add. 1914.1.

Miscellanea: Various notes on bass culture. Arnold, I. 1883.1; Bean, T. H. 1889.2; Beeman, H. W. 1907.1; Borne, M. 1885.4, 1886.1, 1887.1; Burrows, C.

A. 1875.1; Cecil, W. A. 1885.1; Clark, F. N. 1906.1; Dean, H. D. 1903.1; Green, S. 1877.1, 1884.1; Henshall, J. A. 1884.3; Hyde, J. F. 1874.1; Leary, J. L. 1904.2; Lovejoy, S. 1905.1; ★Lydell, D. 1903.1–1907.1, Add. 1911.1; Nesley, C. H. 1914.1; O'Brien, M. E. 1889.1; Prince, E. E. 1898.3; Raveret-Wattel, C. 1911.1; Reighard, J. E. 1906.1; Ripple, R. 1909.1; Roosevelt, R. B. 1879.2; Stebbins, B. M. 1880.1; Walderdorff, W. 1901.1; Anon. 169; Buller, Wm. Add. 1905.1; Stranahan, J. J. Add. 1882.1, 1893.1.

Carp culture

Reference should be made to "Pond culture" *above* wherein are cited many general treatises, relating primarily to carp culture.

General treatises. *Text in English.* Hessel, R. **1878.1**, 1884.1; ★Nicklas, C. **1886.1**; Logan, L. B. Add. 1888.1.

Text respectively in French and Italian. Le Play, A. 1889.1; Supino, F. 1911.1,.2.

Text in German. Knauthe, K. 1905.1; ★Knauthe, K., Apstein, C. & others. **1901.1**; Leonhardt, E. E. 1906.8; ★Susta, J. 1888.1, **1905.1**; Vogel, P. 1898.1; Walter, E. 1903.2–1906.1, 1909.2.

Miscellaneous papers *on carp culture, chiefly minor items, notes, etc.*

Text in English. Banditten, E. 1880.1, 1882.1; Barrington, D. 1772.1; Behr, S. 1883.2; Borne, M. 1883.3, 1885.3; Brakeley, J. H. 1884.1–1889.1; Cary, H. H. 1883.1; Davis, H. B. 1883.1; Donaldson, R. J. 1885.1; Eckardt, G. 1883.1; Eckardt, R. 1882.1,.2; Forster, J. R. 1772.1; Gasch, A. 1885.1; Gillespie, S. 1883.1; Himes, C. F. 1876.1; Hunger, O. 1883.1; Leary, J. L. 1904.1; Morriss, T. W. 1883.1; Nicklas, C. 1883.1, 1884.1, .2; Owen, R. 1860.1; Poppe, J. A. 1876.1; Rixford, G. C. 1880.1,.2, 1882.1; Scudder, C. W. 1884.1; Smiley, C. W. 1886.1; Smithers, E. J. 1885.1; Stabler, E. 1883.1; Stabrowski, X. 1887.1; Stover, E. S. 1884.1, 1885.1; Trybom, F. 1887.1; Van Antwerp, W. 1883.1; Yoakum, F. L. 1883.1; Yost, J. 1883.1; Gross, J. Add. 1886.1. —*Boxes for protection of eggs and young.* Wheeler, L. T. 1884.1.

Text in French. Burda, V. 1898.1; Künstler, J. 1910.1; Meugnot, A. 1908.1; Snickt, L. 1896.2.

Text in German, chiefly relating to carp culture in Germany. Berger, – 1875.1; Bruhns, E. 1877.2; Burda, V. 1898.2; Colb, – 1904.1; Cordes, F. 1871.1; Eben, – 1877.1; Gaertner, F. 1898.1; Giesecke, E. 1901.2; Hoffbauer, C. 1907.1; Jacobs, E. 1879.1; Leonhardt, E. E. 1905.3; Milker, – 1877.1; Müller, A. 1880.1; Reitter, E. 1880.1; Schiemenz, P. 1905.3; Schulze, T. 1911.1; Strüvy, R. 1876.1; Treskow-Weissagk, – 1878.1, 1883.1; Veckenstedt, E. 1877.1, 1880.1; Vogel, P. 1898.1; Wanke, – 1901.1; Anon. 69, 74, 213; Heyking, Add. 1911.1, 1912.1, 1913.1; Victorini, W. M. Add. 1775.1.

Catfish culture

Rearing catfish in ponds. Gardner, A. P. 1883.1; Jones, J. F. 1884.1; Jordan, D. S. 1884.5; ★Kendall, W. C. 1910.1; Leary, J. L. 1910.1.

Cod culture

First effort at artificial fertilization of cod, March, 1865, at Lofoten Is., Norway. Sars, G. O. 1865.1–1879.7.

First American hatchery established in 1878 at Gloucester, Mass. Earll, R. E. 1880.1.

Propagation of cod, 1880–87, at U. S. Fish Comm. Station at Woods Hole, Mass. Atkins, C. G. 1889.1; Bumpus, H. C. 1898.1–1898.4,.7, 1899.1,.2, 1900.1; Carswell, J. 1889.1; McDonald, M. 1884.2; Ryder, J. A. 1886.11; Anon. 468.

Methods employed by U. S. Bureau of Fisheries. Anon. 574.

Cod culture at marine hatchery of Flödevig near Arendal, Norway. Artificial hatching of naturally spawned eggs from fishes retained in ponds. Dahl, K. 1906.1,.2, 1907.1, 1909.2; Dannevig, G. M. 1887.1–1910.2; Rognerud, C. 1889.1. —*Apparatus and methods.* Dannevig, G. M. 1910.1. *See also under* Norway, *below.*

Cod culture at hatcheries of Dunbar and Bay of Nigg, Aberdeen, of Fishery Board for Scotland. Dannevig, H. C. 1896.1; Fulton, T. W. 1903.4.

Eel culture

References to the extensive cultivation of eels, by the rearing of young eels induced to enter areas later closed, as practised at Arcachon and especially the Lagoon of Comacchio, will be found *below* under "Marine fish farming" *under* France, *and* Italy.

Attempted introduction of eels into California. Smith, H. M. 1896.3; Stone, L. 1882.3.

Stocking inland waters of France with young eels. Soubeiran, J. L. 1865.1,.2.

Introduction of eels into the Danube. Haack, H. 1877.1, 1879.1,.5; Petsoldt, –. 1880.1; Walter, E. 1910.1; Widdrington, S. E. 1841.1.

Stocking of streams and lakes or transplanting eels in Germany. Hermes, O. 1880.1; Lübbert, H. O. 1910.1, 1913.1; Schreiber, K. 1896.1; Stemann, – 1878.2, 1879.1; ★Walter, E. 1910.2.

Flatfish culture

Plaice. *Hatching from naturally deposited spawn of confined fishes at Marine Hatchery, Bay of Nigg, Aberdeen, and Dunbar Marine Hatchery (now dismantled) of the Fishery Board for Scotland.* ★Dannevig, H. C. 1896.1–1901.1; Fulton, T. W. 1896.1,.2, 1903.4, 1909.1.

Plaice culture at hatchery at Piel-in-Barrow, England. Herdman, W. A. 1905.1.

Culture of Plaice at station of Haegadalen near Trondhjem, Norway. Nordgaard, O. 1909.1, 1914.1.

Plans for increasing supply in North Sea. Pettersson, O. & Schneider, G. 1908.1.

Pisciculture — *Cont'd.*

Sole. *Culture at Marine Laboratory at Concarneau, France.* ★Fabre-Domergue, P. & Biétrix, E. 1901.1–**1905.1.** — *Notice of this work.* Coupin, H. 1905.1.

Turbot. *Early experiments with turbot at St. Vaast-La-Hougue, France.* Coste, P. 1861.1.

Normal hatchings of turbot first obtained in 1898 at Marine Laboratory at Tatihou near St. Vaast-la-Hougue. Dantan, L. 1905.1; Malard, A. E. 1899.1.

Turbot successfully reared past resorption of umbilical sac. ★Anthony, R. 1907.2, 1908.1, 1910.1.

Grayling culture

Early attempts in U. S. at grayling culture. Clark, F. N. 1880.1; Collins, A. S. 1874.2; Roosevelt, R. B. & Green, S. 1879.1. — *Methods in grayling culture.* ★Henshall, J. A. 1898.1–1900.1, 1907.1. — *Hatching grayling at the N. Y. Aquarium.* Townsend, C. H. Add. 1913.4.

Aesche *or European grayling. Culture at Hüningen, Alsace.* Borne, M. 1878.4; Haack, H. 1878.2.

Herring culture

First artificial fertilization and hatching of herring. Meyer, H. A. 1879.1, 1880.1. — *Method of fertilization.* Ewart, J. C. 1884.3.

Mullet culture

Rearing mullet in fresh-water at St.-Valéry-sur-Somme, France. Blanchet, M. 1914.1.

Experiments in mullet culture at Port-de-Bouc, France, through rearing of fry induced to enter ponds later closed. Feddersen, A. F. 1869.1; Moquin-Tandon, G. & Soubeiran, J. L. 1865.1; Vidal, J. L. 1866.1–1871.1.

Similar pond culture of mullet in Hawaiian Is. Moser, J. F. *in* Rept. U. S. Fish Comm. XXIII, 1897 (1898), p. clxix.

Information on possibility of propagation of mullet in Florida. Ravenel, W. 1889.1.

Pike culture

Various papers on European culture of pike (Esox lucius). Nordqvist, O. F. 1911.2; Winkler, R. 1911.1; Michaelis, A. Add. 1910.1; Rücke, – Add. 1911.1.

Pike-perch culture

Experiments and results of artificial fertilization of pike-perch in America. Downing, S. W. 1906.1, Add. 1911.1; Mather, F. 1891.3; Nevin, J. 1888.1, 1889.1; Reighard, J. E. 1891.1–1893.2; Stranahan, J. J. 1894.1.

Sander *or European pike-perch (Lucioperca sandra). Methods of culture.* Horak, W. 1876.2; Raveret-Wattel, C. 1912.1; Ritter, B. 1906.1.

Culture in Finland. Huebner, A. 1898.1; Nordqvist, O. F. 1900.7, 1905.1, 1906.1; Sandman, J. A. 1899.1. — *in Germany.* Knauthe, K. 1891.7. — *in Sweden.* Limborg, H. 1886.1, 1899.1; Lönnberg, A. J. 1899.8.

Salmon culture

Atlantic salmon. *(Salmo salar) propagated by U. S. Bureau of Fisheries on the Penobscot R., Maine, and at the Craig Brook hatchery and enclosures for ripening nearby at Dead Brook, Bucksport.*

Methods, history, etc. ★Atkins, C. G. 1872.2–1912.1, **1874.1,** Add. 1884.1–1914.1, *also his article in* Anon. **574.**

Landlocked salmon chiefly at Grand Lake Stream, Maine. Atkins, C. G. 1876.2–1885.3; Buck, W. O. 1910.1; Todd, F. 1882.1.

Pacific salmon. *First hatchery of U. S. Fish. Comm. established by L. Stone in 1872 on the McCloud R., tributary of Sacramento R., Cal., at a point later named Baird.*

History of this station, methods employed, etc. ★Stone, L. 1874.3–1889.2, **1897.1.** — *Popular account.* Turner, W. M. 1875.1.

Methods employed in culture of Pacific salmons. General. Downing, S. W. 1901.1; Titcomb, J. W. 1910.1; Rutter, C. Add. 1904.1; Schofield, N. B. Add. 1898.2; Stone, L. *in* Anon. **574.** *For extension of this, see* ★O'Malley, H. *in* Rept. U. S. Fish. Comm. 1919 (1921), Append. II, 32 p., Doc. 879. — *taking eggs by incision.* Bower, W. T. 1906.1. — *proper age at time of planting.* Gilbert, C. H. 1914.1. — *separating live and dead eggs by use of salt solution.* O'Malley, H. 1906.1. — *rearing and feeding fry.* Shebley, W. H. 1915.1. — *burial of eggs.* Babcock, J. P. Add. 1911.1.

Afognak I., Alaska, or similar locality proposed as a national salmon park. Stone, L. 1893.1; Bean, T. H. 1892.9.

European salmon. *General treatises on salmon culture, text in English.* Ashworth, E. & Ashworth, T. 1853.1; Ashworth, T. 1866.1; Fitzgibbon, E. & Young, A. 1850.1; Ramsbottom, R. C. 1854.1.

Gen. treat., text in French. Raveret-Wattel, C. 1904.1.

Various papers on methods, etc. Andrews, T. 1883.1; Bergasse, – 1852.1; Caustier, E. 1907.1; Hogg, J. 1838.1, 1854.1; La Blanchère, P. 1869.3; Mackenzie, F. A. 1842.1; Mir, E. 1908.1.

For culture in various countries, see below under British Isles, Denmark, Finland, France, Germany, Norway, Spain, Sweden *and* Switzerland.

Shad culture

American shad. *(Clupea sapidissima.)*

First shad hatched by Seth Green at South Hadley Falls, Mass., 1867. Clift, (Rev.) W. 1873.1; Green, S. 1880.3; Peirce, M. P. 1880.2,.3,.4.

Methods in culture as practised by U. S. Bureau of Fisheries, chiefly upon its steamers, "Fish Hawk," "Halcyon," and "Lookout." Baird, S. F. 1874.27; Griswold, C. D. 1876.1; Hamlen, W. 1889.1; Mather, F. 1876.1,.8; Milner, J. W. 1874.4–1880.4; Smith, J. A. 1885.1–

1889.5; Wood, W. M. 1884.3,.6; Anon. **574.** — *Effect of sunlight upon eggs.* Page, W. F. 1885.1. — *Experiments upon retarding development of shad.* Rice, H. J. 1884.1; Ryder, J. A. 1882.8. — *Possible expansion of hatchery work.* Worth, S. G. 1910.1.

Shad hatching in various localities. — *Florida rivers.* Cary, H. H. 1885.1; Hamlen, W. 1884.1. — *in South Carolina.* Huske, C. J. 1883.1, 1884.2. — *N. Y., Cold Spring Harbor.* McDonald, M. 1884.10. — *Alabama, Coosa R.* Smiley, C. W. 1883.12. — *Maine. Results of planting shad in Kennebec R.* Smith, E. 1889.1; Stilwell, E. M. 1874.2. — *Operations at the navy yard station, Washington, D. C.* Wood, W. M. 1884.5. — *Albemarle Sound.* Worth, S. G. 1883.2. — *Operations at Havre-de-Grace, see below under* Pisciculture, Maryland.

Maifish. (*Clupea alosa*) *Culture in France.* Vincent, P. 1890.1.

Culture in Germany. Behr, S. 1879.2; Eckardt, R. 1878.1, 1879.4; Hoek, P. P. 1895.2, 1897.3, 1899.1.

Smelt culture

Smelt successfully hatched from naturally deposited eggs by the New York Fish. Comm. at Cold Spring Harbor. Mather, F. 1886.4, 1887.4, 1895.1. — *Experiments of C. G. Atkins.* Baird, S. F. 1875.25.

Spanish Mackerel culture

Various papers on culture of Spanish mackerel in U. S. Earll, R. E. 1883.2, 1884.1; McDonald, M. 1884.11; Smiley, C. W. 1881.1; Verrill, A. E. 1880.1; Wood, W. M. 1885.1. — *Apparatus for hatching Spanish mackerel.* Kite, J. A. Add. 1885.1. — *Utility and methods of propagation.* Moore, J. P. Add. 1898.1.

Striped Bass culture

Propagated chiefly at Weldon and vicinity of Albemarle Sound, North Carolina. For details see Worth, S. G. 1882.1, 1885.1,.2, 1905.1, 1910.1, Add. 1884.2, 1903.1. — *First propagation of striped bass by M. G. Holton, at Weldon, N. C.* Milner, J. W. 1874.4. — *Various items.* Akers, G. F. 1879.1; Blackford, E. G. 1879.3; Green, S. 1883.1; Norny, E. R. 1882.1,.2, Add. 1885.1; Burns, F. Add. 1887.1.

For successful acclimatization in California, see Introduction, *above.*

Sturgeon culture

In this country, in spite of the increasing scarcity, sturgeon propagation is still in the experimental stage. In addition to the initial difficulty in securing ripe fishes of both sexes at the same time, which necessitates impounding with subsequent frequent infertility of eggs, the adhesive nature of the eggs is an additional obstacle. They have usually been hatched in floating boxes and have been frequently subject to fungus attacks. Further difficulties have been met with in the tendency of the female to "throw" or violently expel all her eggs immediately when drawn from the water. This difficulty has been partially met by the insertion of a plug in the genital pore. Attempts at rearing the young have been unsuccessful, owing to the failure of the young to eat.

In Russia, however, on some of the rivers flowing into the Caspian Sea such as the Ural and Volga, efforts have been more successful and numbers of young have been produced. It seems that sturgeon eggs become ripe only when both male and female are kept together in the same enclosure. The naturally muddy river water was used to overcome the adhesiveness of the eggs. Details of this Russian work are given below and in a brief note by N. A. Borodin in the Rept. U. S. Comm. Fish., 1919, Appendix III, pp. 6–7.

First hatching in America of sturgeon by Seth Green in 1875 at New Hamburg, N. Y. Baird, S. F. 1875.34; Roosevelt, R. B. & Green, S. 1879.1.

Experiments on Delaware R. at Delaware City, Del. Dean, B. 1893.6; Ryder, J. A. 1890.4. — *Impounding sturgeon on Delaware R. at Bristol, Pa.* Meehan, W. E. 1910.1.

Experiments in Lake Champlain basin in Vermont. Carter, E. N. 1905.1; ★Stone, L. 1902.1. — *on Hudson R.* Green, S. 1883.1. — *on St. Clair R., Michigan.* Post, H. 1891.1.

German experiments in sturgeon culture on Elbe R. Frauen, M. 1878.1; Müller, T. 1879.1; Quantz, H. 1903.1; Jacobson, H. Add. 1891.1.

Russian methods. *Culture on Ural R.* Borodin, N. A. 1885.1.

Earliest Russian experiments in artificial fertilization of sturgeon. Kovalevskii, Ovsjannikov & Wagner. 1870.1; Knoch, J. 1871.1. — *Comment on Knoch.* Borne, M. 1878.6.

Various papers with text in Russian on successful sturgeon culture. Borodin, N. A. 1902.1; Desnickij, V. M. 1912.1; Kuchin, I. B. 1910.1; Meissner, V. I. 1908.1; Tichenko, S. 1907.1. — *Food and development of young.* Ergomysev, N. Add. 1914.1. — *Rearing of fry.* Peltzam, E. D. Add. 1876.1.

Trout culture

General treatises. *Text in English.* Capel, C. C. 1877.1; Custance, F. H. 1898.1; Green, S. & Collins, A. S. 1870.1; Slack, J. H. 1872.1; ★Stone, L. **1872.3.**

Text in French. ★Blanchon, H. **1911.2;** Diessner, B. 1902.1.

Text in German. Mayer, J. 1876.1; ★Vogel, P. 1898.1; Walter, E. 1906.1.

Text in Italian. Stone, L. 1884.5.

Methods in trout culture. Arens, C. 1906.1; Bower, S. 1896.1; Butler, W. 1900.1; Cheney, A. N. 1898.3, 1900.2; Collins, A. S. 1870.1, 1873.1, 1874.2, 1876.1; Cummings, H. 1882.1; Dykeman, J. R. 1874.1; Fullerton, S. F. 1912.1; Gardner, A. P. 1883.1; Gilbert, W. L. 1894.1; ★Hein, W. 1906.1, 1907.1; Koss, R. A. 1883.1; Léger, L. 1913.1; Lemmermann, E. 1897.1; Mather, F. 1872.1, 1874.1, 1875.2; Porter, B. B. 1878.4; ★Seagle, G. A. 1896.1, 1903.1; Seal, W. P. 1893.1; Stirling, J. 1883.1; Stone, L. 1872.2, 1879.6, 1885.6; Sykes, A. 1903.1; Thompson, W. T. 1912.1; Langguth, T. G. Add. 1913.1. — *Prospective returns for surface area in trout ponds.* Raveret-

Pisciculture — *Cont'd.*

Wattel, C. 1915.1. —*Collection and use of wild spawn.* Titcomb, J. W. 1898.1. —*Sanitary hatching apparatus.* Vincent, E. 1910.1.

Earliest paper on artificial fertilization of trout. Jacobi, S. L. 1765.1.

Proper food for trout and methods of feeding. Allen, G. R. 1906.1; Baird, S. F. 1871.17, 1875.11; Clapham, T. 1880.1; Forbes, H. O. 1897.1; Green, S. 1876.1, .4,.7; Haemmerle, O. 1876.1; Lampert, K. 1900.1; Land, S. E. 1898.1; Nicklas, C. 1884.2; Overbeck, G. 1880.1; ★Page, W. F. 1895.1; Paige, C. L. 1910.1,.2; Revoil, C. 1892.1; Seemann, – 1861.1; Steuert, L. 1901.1; Thompson, W. T. 1901.1; Weeger, E. 1900.1; Harz, C. O. Add. 1884.1. —*Molluscs.* Blanchet, M. 1912.1. —*Tadpoles.* Eckstein, K. 1901.1. —*Tubifex.* Fehlmann, J. W. 1912.2; Simms, G. E. 1912.1. —*Fresh-water shrimp, Gammarus.* Mather, F. 1897.1,.2. —*Automatic arrangement for feeding.* Rueff, A. 1876.1. —*Fish meal as food.* Embody, G. C. Add. 1914.1.

Stocking trout streams; proper means with selection of fry or fingerlings, etc. Brackett, E. A. 1893.1; ★Evermann, B. W. 1905.13; Green, S. 1876.7, 1880.5; Holberton, W. 1883.1; Maitland, J. 1892.1; Mather, F. 1893.1; Prince, E. E. 1901.2; Van Cleef, J. S. 1886.1, 1896.1; Wozelka-Iglau, K. 1891.1; Cheney, A. N. Add. 1897.1; Meehen, W. E. Add. 1905.1.

For trout culture in various countries, see below under Austria, Bohemia; British Isles; Denmark; Finland; France; Germany; *and* Switzerland.

Whitefish culture

American whitefish (Coregonus clupeiformis), artificially fertilized and hatched by U. S. Fish Comm., chiefly on the Great Lakes, Detroit R., and at Northville, Michigan. Baird, S. F. 1876.11; Bissell, J. H. 1893.1; Bower, S. 1884.1, 1896.1; ★Clark, F. N. 1881.1–1908.2; Curtis, J. E. 1884.1; Downing, S. W. 1905.1, 1908.1; Gauthier, C. W. 1911.1; Green, C. K. 1899.1; Green, S. 1875.7; Metcalf, M. 1887.1; Parker, J. C. 1889.1; Reighard, P. 1910.1; Sterling, E. 1876.1, 1877.3; Stone, L. 1872.6; Wilmot, S. 1875.1; Anon. **574**; Stranahan, J. J. Add. 1898.1. —*Food of young fish.* Forbes, S. A. 1882.2,.3; Townsend, C. H. 1906.3.

European whitefish. (*Maræne*). *Chiefly in Germany and adjacent waters.* ★Borne, M. 1878.3, 1879.3; Crettiez, J. 1906.2; Lesseux, C. 1903.1; Serlachius, G. A. 1898.1; Stentzel, A. 1876.1; Wengen, – 1871.7.

"*Nordseeschnäpel*" (*Coregonus oxyrhynchus*). Surbeck, G. 1903.2.

"*Grosse or Peipus Maräne*" *from Baltic provinces, in Germany.* Eckhardt, R. 1875.1, 1877.1, 1878.2,.3; Dröscher, W. 1901.1; Surbeck, G. 1905.4, 1907.1; Zur Mühlen, M. 1911.27.

"*Blaufelchen*" (*C. macrophthalmus*), *in Switzerland and Germany.* Haack, H. 1878.2–1882.3; Heuscher, J. 1906.2; Nüsslin, O. 1907.4; Schweizer, W. 1913.1; Anon. 92.

Yellow Perch culture

Various notes on rearing in ponds, treatment of eggs in hatching, etc. Buller, N. R. 1906.1; Gorham, W. B. 1912.1; Robinson, G. 1878.1; Worth, S. G. 1892.1.

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Black bass, carp, catfish, salmon, shad, trout, and whitefish introduced, see above.

Iceland

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Spain

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F. [n. d.]; Wirth, F. 1893.1; Anon. 752.

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Salmon, trout, and whitefish introduced, see above.

Piscicultural establishments. Bettoni, E. & Vincigeurra, D. 1889.1; Byström, C. 1864.1.

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Turkey

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Alaska

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Canada

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Various localities. — *Nova Scotia.* Mellish, J. T. 1879.1; Sinclair, – 1867.1. — *Newfoundland.* Philips, B. 1874.2.

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United States

For introduction of carp, Rhine salmon, shad, and European whitefish, *see above.*

Historical papers relating to the beginning and development of fish-culture in the United States. Austin, A. 1900.1; Cheney, A. N. 1898.4; Garlick, T. 1884.1; ★Goode, G. B. 1881.2; Kinder, 1879.1; ★Milner, J. W. 1874.4; Potter, E. D. 1891.1; Roosevelt, R. B. 1878.1; Nevin, J. Add. 1911.1; Stone, L. Add. 1898.1.

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Michigan. *Miscellaneous papers.* Bean, T. H. 1891.13; Bower, S. 1910.1 (*Rainbow trout*); Dickerson, F. B. 1904.1; Golcher, W. 1877.1; Post, H. 1894.1. — *Bass.* Reighard, J. E. 1906.1.

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Missouri. *Introduction of rainbow trout.* McDonald, M. 1887.1, 1890.1. — *St. Louis, Forest park fish culture.* Anon. 169.

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J. A. 1907.1. — *Need for fish-way in Pend d'Oreille River.* Waterbury, E. B. & others. 1883.1.

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Various localities. — *Lake George.* A., J. 1876.1. — *Lake Champlain.* Baird, S. F. 1875.36; Edmunds, M. C. 1874.1; Stone, L. 1902.1. — *Westmoreland.* Hallock, C. 1874.1. — *Cold Spring Harbor.* McDonald, M. 1884.10; Mather, F. 1885.2–1889.3; *Otsego Lake.* Phinney, E. 1880.1,.2,.4. — *St. Lawrence reservation.* Strough, A. B. 1902.1.

Yellow perch from Skaneateles introduced into Otisco Lake. G., W. 1841.1. — *Annual reports of state fish culturist.* Bean, T. H. 1907.2, 1911.3, Add. 1910.1, 1911.1. — *State hatcheries, report,* 1904–1906. Lawrence, J. D. 1904.1. — *Removal of lampreys from interior waters.* Surface, H. A. 1899.1.

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For operations in Lake Champlain, see Sturgeon culture *above.*

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Wisconsin. Bean, T. H. 1891.24; Hoy, P. R. 1876.1. — *Muscallonge.* Nevin, J. 1902.1.

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Argentina. *First fish-hatchery in South America established at Lake Nahuel Huapi.* Titcomb, J. W. 1906.1.

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Brazil. Ihering, R. 1912.1. — *Introduction of carp.* Couchman, J. W. 1883.1.

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Introduction of goldfish into rivers. Lataste, F. Add. 1894.1.

OCEANICA

Australia. *Victoria.* Allport, C. 1874.1. — *New South Wales.* Gale, A. 1904.1.

Plaice and sole brought from England to Australia. Dannevig, H. C. 1902.2.

Macquaria australisica and Percalates fluviatilis transplanted in N. S. W., and Queensland. Stead, D. G. 1914.1; O'Connor, D. Add. 1897.1.

For introduction of the various salmons and trouts, and whitefish, see above.

Dutch East Indies. *Cultivation of fresh-water fishes.* Holle, K. F. 1861.1, 1871.1, 1873.1. — *Java.* Dabry de Thiersant, P. 1869.1; Eijk, J. A. 1873.1; Gorkom, K. W. 1868.1; Spall, P. W. 1864.1, 1865.1.

Hawaiian Is. *Native pond culture.* Cobb, J. N. 1906.2.

New Zealand. *Miscellaneous papers.* Creighton, R. J. 1881.1; Seed, W. 1887.1. — *Salmon, European trout, and whitefish introduced, see above.*

Philippine Is. *Pond culture.* Radcliffe, L. 1912.3. —*Black bass introduced, see above.*

Tasmania. *Salmon and trout introduced, see above.*

PLANKTONIC FAUNA

Comprising pelagic ova and larvæ of marine Teleostean fishes

For all literature on non-pelagic eggs, *see* Ova and ovum.

Pelagic Larval Fishes

Descriptions of various pelagic larvæ. ★Agassiz, A. **1878.1,** 1883.1, 1886.1; ★Agassiz, A. & Whitman, C. O. **1885.1;** Ryder, J. A. 1887.2.

Miscellaneous papers. Borodin, N. A. 1903.1; Damas, D. 1909.2; McIntosh, W. C. 1890.4; Nordqvist, O. F. 1914.1; Pycraft, W. 1912.1.

References to early developmental stages of larvæ of non-pelagic forms will be found under the fishes in the last section, under Embryology.

Metamorphosis of larval fishes. *Miscellaneous and general.* Gegenbaur, C. 1865.1; Joly, N. 1872.2; Jürss, H. 1913.2; ★Lütken, C. F. **1880.3,** 1881.1; Meunier, A. V. 1867.1; Vinciguerra, D. 1880.1.

Metamorphosis of — Zeus faber. Agassiz, J. L. 1865.2; Harting, P. 1865.2; Lubach, D. 1865.1; Salverda, M. 1865.1. — *Trachypterus.* Emery, C. 1879.1 (I). — *Syngnathus lumbriciformis.* Fries, B. F. 1837.2. — *Mullus.* Lo Bianco, S. 1908.2. — *Scopelidæ.* Mazzarelli, G. F. 1912.1. — *Lepidopus.* Raffaele, F. Add. 1889.1.

For metamorphosis of larval stages of Pleuronectidæ, *including rotation of the eye and changes in optic tract, see* Pleuronectidæ.

Further data on metamorphosis will probably be found in the papers cited under the fish below in the sub-section Various Ova and Larval Fishes.

For transformation of the Leptocephalus stage see under Anguilla; *for Ammocoetes or larval lamprey, see* Petromyzon.

Post-larval stages. Fabre-Domergue, P. & Biétrix, E. 1897.1; McIntosh, W. C. 1887.1, 1889.2. — *Antarctic fishes.* ★Regan, C. T. **1916.3.** — *North Atlantic fishes.* ★Schmidt, E. J. 1904.2–1909.1.

For post-larval stages of particular marine fishes, see under the fish in section Various Ova and Larval fishes *below.*

Pelagic Ova

Methods of determination with tables, and descriptions of various species. ★Agassiz, A. & Whitman, C. 1885.1; Ehrenbaum, E. 1911.4; ★Heincke, F. & Ehrenbaum, E. **1900.1,** 1903.1; Williamson, H. C. 1899.1; Zur Mühlen, M. 1911.16.

Specific gravity of ova. Franz, V. 1910.11; Jacobsen, J. P. & Johansen, A. C. 1908.1; Ryder, J. A. 1886.12. — *Distribution by currents.* Johnstone, J. 1903.1; Redeke, H. C. 1909.1. — *Quantitative distribution throughout North Atlantic.* Lohmann, H. 1903.1. — *Variations in size.* Williamson, H. C. 1895.3.

Floating "rafts" of jelly with imbedded eggs of Lophius. Agassiz, A. & Whitman, C. 1885.1; Fulton, T. W. 1898.3; Prince, E. E. 1891.1; Williamson, H. C. 1911.2.

For the so-called Pelagic "nests," *of Antennarius, see* Nest-building *under* Reproduction.

Plankton Surveys

Results of studies made in various localities on the ova and larvæ of fishes with descriptions of the various forms.

British investigations. *Ova and larval fishes from waters around Scotland.* ★Cunningham, J. T. **1888.1;** Fulton, T. W. 1890.1; McIntosh, W. C. 1894.2, 1895.1; Williamson, H. C. 1899.1, 1911.2,.4; Herdman, W. A. & Riddell, W. Add. 1912.1. — *Collections of S. S. Garland* (1890–1896) *of Fishery Board for Scotland.* Kyle, H. M. 1897.2; McIntosh, W. C. 1890.6; Masterman, A. T. 1893.1, 1897.2; Wallace, W. 1896.1; Williamson, H. C. 1895.1; Williamson, H. C. & Tosh, J. R. 1894.1.

Report on fish-egg cruise of S. S. "Huxley," 1909. Buchanan-Wollaston, H. J. 1911.1.

Teleostean ova and larval forms observed at the Marine Biol. Lab., Plymouth. Browne, F. B. 1903.1; Cunningham, J. T. 1889.3, .4, 1891.6; Hefford, A. E. 1910.1; Holt, E. W. 1897.5; Holt & Byrne, L. W. 1897.1; Holt & Scott, S. D. 1897.1; Clark, R. S. Add. 1914.1.

Ova from Irish Sea and the Isle of Man. Scott, A. 1905.1,.2, 1906.1, 1913.3, 1914.2, 1915.1; Herdman, W. A. & Scott, A. Add. 1911.1.

Investigations, west coast of Ireland. Cunningham, J. T. 1891.10, 1900.1; ★Holt, E. W. 1891.5, **1893.4.**

Dutch investigations. *Ova and larval forms of North Sea fishes.* Boeke, J. 1906.1; Hoek, P. P. 1888.1; Hoek, P. & Ostenfeld, C. H. 1906.1; Ostenfeld, C. & Wesenberg-Lund, C. 1909.1; Redeke, H. C. & Breemen, P. J. 1908.1; Tesch, J. J. 1909.1–1914.2.

German investigations. *Methods and results.* Jenkins, J. T. 1901.1.

Baltic Sea investigations. ★Ehrenbaum, E. & Strodtmann, S. 1904.1; Heinen, A. 1912.1; Hensen, V. 1883.1, 1884.1, 1901.2; Merkle, H. 1910.1; Pietschmann, V. 1914.1.

North Sea investigations. Ehrenbaum, E. 1897.1, 1909.1, 1910.2, 1911.3; Heincke, F. 1905.1; ★Hensen, V. & Apstein, C. 1897.1; Strodtmann, S. 1908.1.

Other localities. *Ova and larvæ from — South Africa.* Gilchrist, J. D. 1903.2,.3, 1904.1. — *Barents Sea.* Linko, A. 1907.1.

Mediterranean Sea. Cialona, M. 1901.1; Facciolà, L. 1884.1; Fage, L. 1910.1; Mazzarelli, G. F. 1910.1–1912.1; Raffaele, F. 1887.1, 1888.1. — *Marseilles, France.* Holt, E. W. 1897.6, 1899.1;

Plankton — *Cont'd.*
Marion, A. F. 1894.9. — *Adriatic Sea.* Steuer, A. 1913.1, 1914.1.

North Atlantic and contiguous waters. — *Skagerrak.* Aurivillius, C. W. 1898.1, 1899.1. —*Faeroe channel.* Holt, E. W. 1898.5. —*Bay of Biscay.* Holt & Byrne, L. 1907.1. —*Bay of Hougue, France.* Perrier, J. & Anthony, R. 1907.1. —*Baltic Sea.* Schneider, G. 1907.4. — *Danish waters.* Apstein, C. 1911.1; Kramp, P. L. 1913.1; Otterstrøm, A. N. 1906.2; Petersen, C. G. 1903.2.

VARIOUS OVA AND LARVAL FISHES

Comprising special papers describing or relating to the planktonic ova and pelagic larval stages of marine teleostean fishes, and including free-swimming post-larval and young forms of these and of forms having "fixed" or attached ova.

Sub-order Acanthopterygii

Gobiiformes. — *Crystallogobius.* McIntosh, W. C. 1896.4.

Jugulares. — *Trachinus.* Boeke, J. 1907.1. —*Blennius.* Byrne, L. W. 1902.1; Emery, C. 1879.1 (viii); Nobre, A. 1895.4; Quatrefages, J. L. 1843.1. — *Callionymus.* Cunningham, J. T. 1891.2; McIntosh, W. C. 1886.2; Prince, E. E. 1891.2. —*Centronotus, Lumpenus, and Lepadogaster.* McIntosh, W. C. 1890.2, 1895.1, 1897.1. — *Uranoscopus.* Fage, L. Add. 1914.2.

Perciformes. — *Chaetodon.* Günther, A. C. 1871.7, 1876.4. — *Acronurus.* Hilgendorf, F. M. 1883.1. — *Pomatomus.* Nichols, J. T. 1914.1. — *Sparus.* Williamson, H. C. 1911.2,.4.

Scleroparei. — *Cyclopterus.* Cunningham, J. T. 1888.1. — *Dactylopterus* (*Cephalacanthus is the larval form*). Hilgendorf, F. M. 1883.1. — *Trigla.* Jaquet, M. 1907.3. — *Cottus.* McIntosh, W. C. 1888.3.

Scombriformes. — *Scomber.* Cunningham, J. T. 1891.4; Marion, A. F. 1894.8; Sanzo, L. 1910.4. — *Xiphias.* Günther, A. C. 1876.4; Sanzo, L. 1910.3; Steenstrup, J. J. 1861.1. — *Alectis.* Osburn, R. C. 1910.10. — *Auxis.* Sanzo, L. 1909.1.

Tæniosomi. — *Trachypterus.* Jacino, A. 1908.1, 1909.1; Lo Bianco, S. 1908.3; Ogilby, J. D. Add. 1888.3.

Zeorhombi. — *Zeus.* Schmidt, E. J. 1908.2; Stiasny, G. 1914.1.

For eggs and larvæ of flat fishes, *see under* Pleuronectidæ *in* Systematic section.

Sub-order Anacanthini

Macruridæ. Emery, C. 1879.1 (ix); Facciolà, L. 1882.4.

Gadidæ. Hoek, P. P. C. 1911.2; Lo Bianco, S. 1911.2; Redeke, H. C. 1909.1; Schmidt, E. J. 1909.1; Redeke, H. C. & Breemen, P. J. van. 1908.1. — *Motella.* Brook, G. 1887.2. — *Phycis.* Facciolà, L. 1883.2; McIntosh, W. C. 1906.1; Yarrow, H. C. 1877.2. —*Gadus.* Hoek, P. 1909.1, 1911.2; McIntosh, W. C. 1886.5, 1894.2, 1895.1, 1897.1; Otterstrøm, A. N. 1906.3; ★Schmidt, E. J. 1904.3, 1905.1, 1906.4. — *Molva.* McIntosh, W. C. 1885.2; Schmidt, E. J. 1906.3, 1907.3; Dunn, M. Add. 1885.3. — *Brosmius.* Schmidt, E. J. 1905.2; Williamson, H. C. 1911.2. — *Merluccius and Raniceps.* Schmidt, E. J. 1907.2, 1907.3, 1908.1.

Sub-order Haplomi

Scopelidæ. Emery, C. 1879.1; Holt, E. W. 1898.1; Mazzarelli, G. F. 1912.1; Sanzo, L. 1915.2. — *Clorophthalmus.* Facciolà, L. 1884.2. — *Stylophthalmoides as larva of Scopelus.* Sanzo, L. 1915.2.

Sub-order Heteromi

Fierasfer. Edwards, T. 1863.2; Fulton, T. W. 1904.1; McIntosh, W. C. 1898.1; Nusbaum, J. & Bykowski, L. 1905.1.

Encheliophis is the larval form of Fierasfer. Putnam, F. W. 1874.4.

Sub-order Malacopterygii

American Clupeidæ. Prince, E. E. 1907.1. — *Clupea pilchardus.* Biétrix, E. 1891.1; Fabre-Domergue, P. & Biétrix, E. 1896.1, .2; Pouchet, G. & Biétrix, E. 1889.1, .2,.6. — *Herring.* Dunn, M. 1897.1; Günther, A. C. 1868.5; Masterman, A. T. 1896.2. — *Clupea alosa finta.* Nordqvist, O. F. 1902.1. — *Gonostoma.* Facciolà, L. 1884.3; Sanzo, L. 1912.1. — *Megalops.* Kampen, P. N. 1909.3. — *Engraulis.* Marion, A. F. 1894.8; Redeke, H. C. 1913.1. — *Synodus.* Nichols, J. T. 1911.1. — *Chauliodus, Stomias, Sternoptychidæ.* Sanzo, L. 1912.2,.3, 1915.2. — *Argentina.* Schmidt, E. J. 1906.2. — *Bathylychnus.* Steuer, A. Add. 1911.1.

Sub-order Percesoces

Ammodytes. McIntosh, W. C. 1892.2; —*Belone.* Cornish, T. 1885.4; Day, F. 1885.13; Hohnbaum-Hornschuch, R. 1843.1; Hoeven, J. 1843.1; Putnam, F. W. 1865.5. — *Centrolophus.* Borsieri, C. 1902.1; Holt, E. W. 1891.4. — *Exocœtus.* Lütken, C. F. 1874.1; Raffaele, F. 1895.2. — *Scomberesox.* Raffaele, F. 1895.2; Steuer, A. Add. 1911.1. — *Hemirhamphus.* Weber, M. 1913.2.

Ova, larvæ, and young of fishes of various other Sub-orders

Amphisile. Duncker, G. 1911.1. — *Lophius.* Günther, A. C. 1861.10; Stiasny, G. 1911.1, 1913.1; Steuer, A. Add. 1911.1. — *Fistularia.* Hilgendorf, F. M. 1877.1. — *Mola.* McCulloch, A. R. 1912.1; Perugia, A. 1889.2; Putnam, F. W. 1870.4; Reuvens, C. L. 1895.4. — *Nemichthyidae.* Roule, L. 1910.2, 1911.2, 1912.1, 1913.4, 1914.1,.5. — *Bathophilus.* Sanzo, L. 1915.2. — *Chlopsis.* Schmidt, E. J. 1913.2.

POISONOUS FISHES

For toxic effects, when injected, of blood serum of fishes, especially Anguilla, *see under* Blood of fishes.

For a recent valuable work in French, with an extensive bibliography, treating the *entire subject of poisonous fishes, including both poison apparatus and poisonous flesh, see* ★Marie Phisalix. "Animaux venimeux et venins." Paris. 1922. *vol.* II, *pp.* 487–628, *illustrations.*

General treatise. Coutière, H. 1899.1. — *Accounts in "Medical Zoologies."* Brandt, J. F. & Ratzeburg, J. T. 1829.1; Moquin-Tandon, C. H. 1860.1; Stephenson, J. 1838.1; Taschenberg, E. O. 1909.1.

Miscellaneous items. Autenrieth, H. F. 1833.1; Berkowsky, –. 1859.1; Dickson, J. H. 1818.1; Dönitz, F. K. 1873.1; Kalm, P. 1761.1; Leonhardt, E. E. 1904.10; Wuth, E. M. 1877.1; Anon. 264–266, 357, 451, 454; Klimenko, W. S. Add. 1894.1; Knoch, J. Add. 1888.1; Schmidt, N. Add. 1891.1; Vasilyeff, S. M. & Mochaloff, M. I. Add. 1885.1. — Pre-Linn. *refs.* Linocier, G. 1584.1; Piso, G. 1648.1.

Alleged Dental Apparatus of Muræna

Descr. of venomous apparatus similar to serpents, formed by palatine teeth with associated mucous glands, in Muræna helena. Bottard, A. 1889.2; Porta, A. 1905.2. — *Popular résumé of Bottard.* Bordas, L. 1907.1.

Investigations of palatine structure and disbelief of presence of poison glands. Coutière, H. 1902.1, 1907.1; Galasso, F. 1901.1; Pavlovskiĭ, E. 1909.1,.4.

Poison Apparatus Composed of Spines and Associated Glands

General accounts of structure, functions, etc. Bassett-Smith, P. W. 1903.1; ★Bottard, A. 1889.1, **1889.2**; Porta, A. 1905.2; ★Pavlovskiĭ, E. 1907.1, 1909.1; Fredericq, L. Add. 1910.1; Lipp, F. J. Add. 1829.1; Paré, A. Pre-Linn. 1575.1.

Treatment of wounds, anti-venomous serotherapy, etc. ★Calmette, A. 1907.1,.2; Bassompierre, – & Schneider, – Add. 1899.1; Lacoste, L. Add. 1911.1.

Miscellaneous papers. Cecca, R. 1902.1; O'Shaughnessy, A. W. E. 1867.1; Thilo, O. 1898.3, 1899.3; Anon. 189, 450; Bottarel, A. Add. 1889.1; Hasselt, A. W. Add. 1862.1; Munier, Add. 1774.1; Sauvages, –. Add. 1764.1. — *Analogy of lesions and symptoms with snake bites.* Corré, A. Add. 1872.1, 1881.1. — *Early ref.* Hanow, M. Pre-Linn. 1737.1.

For dangerous wounds (non-poisonous) made by the sting-ray, Trygon, see Aubert, H. 1861.1; Mordecai, E. R. 1860.1.

Batrachus. *Axillary gland, commonly thought poisonous, is shown not to be.* Wallace, L. B. 1893.1.

Scorpænidæ. *Poison apparatus, structure.* Pavlovskiĭ, E. 1907.2, 1911.1,.3; ★Sacchi, M. 1895.1. — *Nature and effects of Scorpæna poison.* Briot, A. 1904.1, 1905.1; Pohl, J. 1893.1; Dunbar-Brunton, J. Add. 1896.1.

Effects of poisons and cases of poisoning in Synanceia. Harting, P. 1865.5; Le Juge, E. 1871.1; Schnee, S. 1911.1; Anon. 399, 587. — *Notesthes.* Kesteven, L. 1914.1; Woods, J. E. 1882.1. — *Pterois.* Schnee, S. 1908.2.

Siluridæ. *Structure of poison glands and spines in — Ictalurus dugesii.* Alemán, J. 1891.1; Dugès, A. 1891.1. — *Plotosus.* Pavlovskiĭ, E. 1913.1–1914.2. — *Piratinga filamentosa.* Pettit, A. & Geay, F. 1901.1. — *Noturus and Schilbeodes.* ★Reed, H. D. 1900.1, 1907.1, Add. 1906.1.

Thallassophryne. *Anatomy of poison apparatus.* Dow, J. M. 1865.1; ★Günther, A. C. 1864.9, 1869.1; Harting, P. 1864.1; Anon. 211.

Trachinus. *Structure of poison apparatus.* Borley, J. O. 1907.1; Chievitz, J. H. 1888.1; Day, F. 1880.2; ★Gressin, L. 1884.1; ★Parker, W. N. 1888.1, Add. 1888.1; Pavlovskiĭ, E. 1907.2; Schmidt, F. T. Add. 1875.1.

Discovery of venomous properties and poison glands. Allman, G. J. 1841.1; Byerley, I. 1849.1; Woodward, H. 1864.1.

Nature of poison and its effects, hemolytic action, etc. ★Briot, A. 1902.1–1904.2; Evans, H. M. 1907.1, 1910.1; Pohl, J. 1893.1; Phisalix, C. 1899.1; Dunbar-Brunton, J. Add. 1896.1. — *Review of Briot.* Mitchell, C. A. Add. 1906.3.

Records of poisoning cases. Spitzly, J. H. 1910.1; Bassompierre & Schneider Add. 1899.1; Bottard, –. Add. 1885.1; Willius, J. V. Pre-Linn. 1677.1. — *Case of death.* Ulmer, –. 1865.1.

Poisonous Flesh through Presence of Alkaloids

It has not been possible here to distinguish between actual poisoning and ptomaine poisoning. For all papers relating specifically to sickness caused through eating decayed fish, either fresh or preserved, *see under* Diseases of man.

General treatises. See especially. ★Pellegrin, J. **1900.6**; Savchenko, P. N. 1887.1; ★Vignon, G. Add. 1902.1.

Other general accounts. Coutière, H. 1899.1; Corré, A. 1865.1; Duméril, A. H. 1866.2, 1867.1; Fischel, F. & Enoch, C. 1892.1; ★Kobert, E. R. 1902.1, Add. 1894.1; Tybring, O. 1885.1, 1887.1. — *Text in Russian.* Popoff, M. Add. 1887.1.

Miscellaneous papers on the effects of eating poisonous fishes, with references to poisoning cases, etc. Burnett, W. 1846.1; Burrow, G. M. 1815.1; Elridge, S. 1879.1; Gmelin, J. F. 1788.1; Hamilton, W. 1853.1; Lim-Boon-Keng, – & Boddaert, A. 1901.1; Martin, M. 1834.1; Martini, –. 1898.1; Nicolas, C. 1909.1; Nordmann, A. 1863.1; Anrep, V. K. Add. 1885.1; Carruccio, A. Add. 1886.1; Chernisheff, S. P. Add. 1899.1; Cloquet, H. Add. 1821.1; Guyon, – Add. 1856.1; Mouchon, –. Add. 1840.1; Schreiber, J. Add. 1884.1. — *Effect on a cat.* Casselmann, A. 1871.1.

Cases of poisoning. *Records of occurrence, treatment, etc.* Danilewsky, C. 1885.1; Gautier, A. 1864.1; Sobbe, – 1889.1; Alexander, – Add. 1888.1

Poisonous Fishes— *Cont'd.*

Chevallier, – Add. 1856.1; Edwards, J. Add. 1884.1; Raillet, A. Add. 1895.1; Rostoshinski, R. P. Add. 1892.1; Savchenko, P. Add. 1882.1; Simsohn, J. S. Add. 1887.1; Spofforth, J. L. Add. 1886.1; Wilson, J. P. Add. 1887.1.

Poisoning from eating liver of — shark. Coutaud, H. 1879.1. — *Diodon.* Richardson, J. 1861.1. — *sword-fish.* Morrow, C. H. Add. 1896.1.

Poisoning cases from eating roe or eggs of —Barbus meridionalis. Pellegrin, J. & Glaize, E. P. 1903.1. — *herring.* Belin, J. Add. 1886.1. — *"rolled roe."* Bondareff, P. G. Add. 1898.1.

Poisoning from eating the bonito (Gymnosarda). Morvan, A. Add. 1857.1.

"**Ciguatera,**" **in West Indies.** *Produced chiefly by puffers, filefishes, and toadfishes.* Chisholm, C. 1808.1; Ferguson, W. 1823.1; ★Hill, R. 1868.1; Meyer, F. D. 1805.1; Moreau de Jonnès, A. 1819.1; Morton, C. 1865.1; Parra, A. 1787.1; ★Poey, F. 1865.1; Anguita i Stüven, V. Add. 1897.1; Desports, J. B. Add. 1770.1; ★Fonssagrives, J. B. & Mericourt, L. Add. 1861.1; Janière, S. Add. 1831.1; Oldendorps, –. Add. 1777.1; Rogers, J. M. Add. 1899.1; Ulloa, A. Add. 1772.1; Chevalier, J. D. Pre-Linn. 1752.1; Locke, J. L. Pre-Linn. 1675.1; Martyr, P. Pre-Linn. 1504.1. — *Poisoning by barracuda.* Plée, – Add. 1829.1.

Tetrodon poisoning, chiefly in Japan. Bennett, G. 1870.1; Goertz, A. 1878.1; Osbeck, P. 1765.1, 1771.2; Pappe, C. W. 1854.1; ★Remy, C. 1883.1; Schreitmüller, W. 1910.14; ★Salanone-Ipin, H. Add. 1889.1.

Researches on nature, chemical composition and physiological action of Tetrodon poison. Tahara, Y. 1910.1, Add. 1896.1, 1912.1; Takahashi, D. & Inoko, Y. 1889.1, 1892.1; Hayashi, H. & Muto, K. Add. 1901.1; Miura, M. & Takesaki, K. Add. 1890.1.

Miscellaneous, text in Japanese or Russian. Akashi, T. 1880.1; Noro, K. 1880.1; Furuya, –. Add. 1881.1; Gubareff, P. M. Add. 1882.1; Osawa, K. Add. 1884.1; Takei, S. Add. 1831.1; Yamawaki, G. Add. 1883.1.

Various localities. *Cases of poisoning by eating, and lists of poisonous fishes of — southern Pacific Ocean.* Anderson, W. 1776.1; Brenchley, J. L. 1873.1; Wilson, J. Add. 1799.1. — *Mauritius I.* Baird, S. F. 1872.26; Sonnerat, P. & Meunier, V. 1774.1. — *Dutch East Indies.* Moreau de Jonnès, A. 1821.1; Woods, J. E. 1888.1. — *New South Wales.* Pattison, G. J. 1872.1. — *New Caledonia.* Roux, – (Jr.) 1860.1. — *Philippine Is., by Spheroides.* Seale, A. 1912.2, Add. 1912.1. — *Mediterranean.* Slyunin, N. V. Add. 1892.1. — *Marshall Is.* Steinbach, –. Add. 1895.1.

Belief in tropics that exposure to moon renders fish poisonous. Goode, G. B. 1879.8; Bryant, E. G. Add. 1912.1; Hutchins, D. E. Add. 1912.1.

POST-BRANCHIAL BODY

Called also Suprapericardial body.

For related structures, *see* Thymus, *and* Thyroid glands.

Morphology of the post-branchial body. Bemmelen, J. F. 1886.1; Giacomini, E. 1909.1, 1912.1; Herrmann, G. & Verdun, P. 1900.1; Maurer, F. 1886.1; Supino, E. 1907.2; ★Thompson, F. D. 1910.1.

PREDATORY FISHES

For the reverse, *i. e.* animals destructive to fishes, *see* Noxious organisms *under* Pisciculture.

For a related topic, *see* Poisonous fishes.

Miscellaneous or popular articles on voracity of fishes. Anderson, A. 1879.1; Kornhuber, G. A. 1901.1; Steele, R. L. 1876.1.

Means of defense and attack, popular acc'ts. Brüning, C. 1903.2; Coupin, H. 1913.1; ★Cuénot, L. 1898.1; Faussek, V. A. 1908.1; Lönnberg, A. J. 1901.4.

Effects of wounds produced by sting-ray, Trygon. Aubert, H. 1861.1; Duméril, A. H. 1865.4; Mordecai, E. R. 1860.1. — *Wounds made by garfish, Belone.* Mühlens, P. 1904.1.

Barracuda dangerous to man. Brenchley, J. L. 1873.1. — *Devil-fish (Ceratoptera) interfering with submarine diver.* Anon. 60.

Cutting of a cable at Singapore by a sawfish (Pristis). Anon. 478.

Serrasalmo (Caribe) attacking men. Eigenmann, C. H. 1915.2; Paez, R. 1862.1; Roosevelt, T. 1914.1; Anon. 251; Lange, A. Add. 1912.1; Woodroffe, J. F. Add. 1914.1.

Sharks as man-eaters. Lucas, F. A. 1916.1; Smith, H. M. 1905.6, 1916.2; Swan, J. O. 1880.1; Griffen, S. Add. 1881.1.

Notes on the voracity of sharks. Duméril, A. H. 1865.4; Verney, (*Lady*) 1874.1; Anon. 252; Adams, A. Add. 1848.1; Becke, L. Add. 1905.1.

Swordfish in stomach of Carcharias. Atwood, N. E. 1864.3. — *Human remains in stomach of Carcharodon.* Condorelli-Fr., M. & Perrando, G. 1909.1. — *Acc'ts of sharks attacking boats.* Foulis, R. 1852.1; Putnam, F. W. 1874.9.

Swordfishes attacking vessels, and fighting whales. *Vessels pierced by weapon.* Gray, J. E. 1871.1; M'Calmont, R. 1844.1; Thompson, W. 1844.3; S., J. M. Add. 1835.1. — *Refs. in* Pre-Linn. *section.* Baeck, A. 1748.1; Josselyn, J. 1674.1; Mortimer, C. 1744.1. — *Man killed in boat attacked.* Wilcox, W. A. 1887.2.

Acc'ts of fights with whales. Lütken, C. F. 1877.3; Maclaren, M. 1909.1; Anon. 313. — *Alleged coöperation of fox-shark, Alopecias, in these attacks.* Day, F. 1881.2 (*p. 55*). — Pre-Linn. *refs.* Cooke, E. 1712.1; Hawkins, R. 1622.1; Josselyn, J. 1674.1; N. 1791.1.

Voracious habits of various predatory fishes. The titles of the following papers indicate voracity in the following species.

Voracious habits of the "gar-pike," Lepidosteus. Abbott, C. C. 1867.1; Caldwell, E. E. 1913.1; Hussakof, L. 1914.1; Boucher, P. Pre-Linn. 1664.1; Champlain, S. Pre-Linn. 1632.1; Charlevoix, P. F. Pre-Linn. 1744.1.

Voracity in the true pike and pickerel (Esox and Lucius). Abbott, C. C. 1876.2; Corbin, G. B. 1873.1; E., W. W. 1874.1; Hagenow, K. F. 1860.1; Hintze, A. 1894.2; Stirling, A. B. 1863.1; Wagner, C. 1880.1; Canestrini, R. Add. 1886.1; Arnault de Nobleville, L. D. Pre-Linn. 1756.1.

Voracious feeding habits of the "angler," Lophius. Blake-Knox, H. 1865.1; Fulton, T. W. 1903.1; Anon. 559; Guitel, F. Add. 1913.1.

Voracity of — Stizostedion. Bean, T. H. 1890.37. — *Belone.* Clogg, S. 1874.2. — *Bdellostoma.* Delfin, F. T. 1900.3.

Probable predatory habits of Palæoniscidæ. Traquair, R. H. 1879.1.

"RAINS OF FISHES"

Comprising accounts of fishes which, after being taken up in waterspouts, are transported to some distance and come down with the rain.

Records of occurrences throughout the world. August, –. 1841.1; Baird, S. F. 1873.3; Buchenau, F. 1873.1; Castelnau, F. L. 1861.2,.3; Dekay, J. E. 1842.2; Harting, P. 1861.2; Hubbard, O. P. 1859.1; Landois, H. 1896.1; Muse, J. E. 1829.1; Sharpe, W. 1875.1; Sykes, –. 1840.1; Tennent, J. E. 1861.1; Anon. 226, 227; Arnot, –. Add. 1826.1; Baker, T. R. Add. 1893.1; Boll, E. F. Add. 1858.1, 1868.1; Eglini, R. Add. 1771.1; Gardner, J. W. Add. 1902.1; Harriott, J. Add. 1809.1; P[rinsep], J. Add. 1833.1; Rees, A. Add. 1819.1; S., –. Add. 1834.1; Smith, C. Add. 1826.1; Symson, A. Add. 1823.1; Thompson, D. P. Add. 1849.1; Tomlinson, C. Add. 1865.1; Athenæus, N. Pre-Linn. 1680.1; Conny, R. Pre-Linn. 1698.1.

For a popular account, containing reprints of all original records of "Rains of fishes" with a complete bibliography, see ★E. W. Gudger *in* Natural History (Journ. Amer. Mus.), 1921, vol. xxi, no. 6, pp. 607–619.

REGENERATION

The reproduction or regrowth of parts which have been lost or destroyed.

For a closely related subject, *see* Teratology.

General treatises. ★Morgan, T. H. 1901.1, 1907.1; Przibram, H. 1909.1.

Miscellaneous papers. Broussonet, P. M. 1786.1; Eismond, O. P. 1910.1, 1912.1; Nusbaum, J. 1903.1, 1907.3; Scott, G. G. 1909.1.

Heteromorphosis in regeneration. Nusbaum, J. 1903.2. — *Mechanism of regeneration.* Tornier, G. 1906.1.

On regeneration in vertebrate embryos including those of fishes. Barfurth, D. Add. 1903.1.

Regeneration of various parts of the body

Regeneration of numerous parts, such as the fins, operculum, scales, etc., in — Amphioxus. Biberhofer, R. 1906.1. — *Fundulus.* Morrill, C. V. 1906.1. — *Salmo.* Nusbaum, J. & Sidoriak, S. 1900.1.

Regeneration of barbels in Siluroids. Beigel, C. 1912.1; Roth, W. 1905.2.

Regeneration of fins generally. Beigel, C. 1910.1; Bogacki, K. 1906.1; Lachmann, H. 1891.1; Philipeaux, J. M. 1869.1; Scott, G. G. 1907.1, 1909.1,.2; Suvorov, E. K. 1904.1.

Nerve formation in transplanted fin anlagen. Braus, H. 1905.1.

Regeneration of caudal fins. Bert, P. 1863.1; Clarke, F. W. 1874.1; Duncker, G. (*Syngnathidæ*) 1905.1; Mazza, F. 1890.2; Scott, G. G. 1909.2.

Regeneration of tail. — General researches. ★Morgan, T. H. 1900.1, 1902.1. — *Caudal region, Pleuronectes.* Boulenger, G. A. 1908.5. — *Protopterus.* Léger, L. 1897.1; Traquair, R. H. 1871.4. — *Petromyzon.* Studnička, F. K. 1912.3.

Regeneration of various other portions of the body. — Operculum and skin. Beigel, C. 1910.1, 1911.1. — *Crystalline lens in teleosts.* Grochmalicki, J. 1908.1,.2,.3. — *Nerves.* Kolster, R. 1899.1. — *Blood vessels.* Minervini, R. 1911.1. — *Scales.* Ryder, J. A. 1884.4; Scott, W. 1911.1. — *Muscle fibers (striated).* Schmincke, A. 1907.1.

REPRODUCTION

Comprising Breeding habits, and general reproductive behavior.

For the extensive literature on the breeding habits and related activities of Anguilla, Pleuronectidæ, and Salmonidæ, *see under* these headings in the Systematic section.

For the morphology of the Reproductive organs, Ovary, *and* Testis, *see under* Urinogenital system. For the reproductive elements, *see* Ova and Ovum, *and* Spermatozoa.

For related subjects, *see* Embryology; Hermaphroditism; Hybrids; Migration; etc.

Miscellaneous references. Au, W. 1912.1; Beard, J. 1897.2; Bertrand, Em. 1893.1; Carbonnier, P. 1881.1,.2; Cavolini, F. 1787.1, 1792.1, 1808.1; Coste, P. 1858.1; Day, F. 1886.3; Ehrenbaum, E. 1908.1; Emeljanenko, P. E. 1908.1; Langguth, G. A. 1777.1, 1780.1; Lebert, H. 1845.1; Merk, M. 1911.1; Nikitin, S. 1889.1; Richardson, R. E. 1913.1,.2; Ritgen, F. A. 1820.1; Schreitmüller, W. 1910.10; Sivard de Beaulieu, G. 1851.1, 1852.1; Holzfuss, E. Add. 1914.2.

Early views, references in Pre-Linn. *section.* Balduin, G. 1667.1; Fabricius, d'A., J. 1621.1; Gleditsch, J. 1756.1,.2; Leeuwenhoek, A. 1691.1–1702.1.

BREEDING HABITS

Comprising only the general unspecified breeding habits. For specific breeding habits see below in this section.

Breeding habits may also be looked for under the heading Natural History *under the fish in the* Systematic section.

Reproduction — *Cont'd.*

CYCLOSTOMATA

Breeding habits of Petromyzon. Frauen, M. 1879.1; Gage, S. H. 1911.1; Loman, J. C. 1910.1; Vieira, L. 1894.5.

DIPNOI

Breeding habits of Protopterus. Budgett, J. S. 1900.2,.5, 1907.1. —*Lepidosiren.* Kerr, J. G. 1897.1, 1900.1. — *Ceratodus.* Semon, R. 1893.1, 1899.1, 1903.1.

ELASMOBRANCHII

The highly specialized breeding habits of Elasmobranchii will be found below under Copulation, Oviparity, *and* Viviparity.

GANOIDEI

Breeding habits of Acipenser. Dean, B. 1895.3. — *Amia.* ★Dean, B. 1895.2, 1896.5, 1899.4; ★Reighard, J. E. 1900.1, 1901.2, 1902.1, **1904.2**, Add. 1902.1. —*Lepidosteus.* Dean, B. 1895.3.

TELEOSTEI

The highly specialized breeding habits of various Teleosts will be found below under Parental Care *and* Viviparity.

Breeding habits of freshwater fishes of the state of Illinois. Richardson, R. E. 1912.1,.2.

For further like observations on Illinois fishes, see T. L. Hankinson *in* Trans. Illinois Acad. Sci., 1919, vol. 12, pp. 132–150.

Sub-order Acanthopterygii

Breeding habits of — Cichlasoma. Borchardt, F. 1913.1. — *Cyclogaster.* Ehrenbaum, E. 1897.1 (iii). — *Krefftius.* Gale, A. 1914.1. —*Betta.* Leonhardt, E. E. 1905.5; Waite, E. R. 1904.2; Fabre-Domergue, P. Add. 1914.1. —*Labyrinthici.* Mandée, R. 1907.1. — *Perca flavescens.* Mather, F. 1892.1. —*Etheostoma.* Reeves, C. D. 1907.1. — *Percina caprodes.* Reighard, J. E. 1913.1. — *Heros.* Tappan, F. L. 1912.1.

Sub-order Haplomi

Breeding habits of — Umbra. Abbott, C. C. 1874.3; Carbonnier, P. 1874.1; Gill, T. N. 1906.2. — *Haplochilus.* Gruber, A. 1911.1.

Sub-order Malacopterygii

Breeding habits of — Gymnarchus. Budgett, J. S. 1900.2. — *Clupea.* Derschau, W. 1894.1. —*Luciotrutta.* Heide, E. J. 1912.2. — *Shad.* Kirtland, F. 1879.1. — *Coregonus.* Maier, H. N. 1910.1. — *Arapaima.* Marcoy, P. 1869.1; Verissimo, J. Add. 1895.1.

Sub-order Ostariophysi

Breeding habits of — Parasilurus, the Glanis of Aristotle. Agassiz, J. L. 1856.2; Gill, T. N. 1906.4. — *Malopterurus.* Babukhin, A. I. 1875.1, 1877.1; Bilharz, T. 1853.1; Du Bois Reymond, E. H. 1881.2; Fritsch, G. T. 1887.1. — *Rasbora.* Bonorden, A. 1911.1, 1913.1. — *Catostomus.* Culbertson, G. 1904.1. — *Cobitis, Leucaspis, and Phoxinus.* Knauthe, K. 1890.1. — *Callichthys.* Liebig, T. 1912.1; Schubert, H. 1907.1. — *Leuciscus.* Milewski, A. 1915.2; Schreitmüller, W. 1912.5. — *Ictiobus (Buffalo fish).* Mosher, A. A. 1885.2. — *Semotilus.* Reighard, J. E. 1910.1. —*Leucaspius.* Tautz, A. 1910.1.

Sub-order Percesoces

Breeding habits of — Mugil. Künstler, J. 1904.1. — *Tylosurus.* Abbott, C. C. Add. 1888.1.

Breeding seasons. *Marine fishes. — British fishes.* Brook, G. 1885.7. — *North Sea.* Ehrenbaum, E. 1908.2, 1910.1. — *San Diego, Cal.* Eigenmann, C. H. 1891.5. — *Gulf of Naples.* Lo Bianco, S. 1888.1. — *French fishes.* Sauvage, H. E. 1891.2. — *Woods Hole, Mass.* Bumpus, H. C. 1898.1,.2,.3, 1899.1; Sumner, B. F., Osburn, R. C., & Cole, L. J. 1913.1; Thompson, M. T. 1899.1.

Fresh-water fishes of France. Coste, J. J. 1869.1; Guillaume, C. E. 1905.1. — *Of Germany.* Vogt, C. C. 1860.1. — *Comparison of times in standing and running water.* Huet, P. 1906.1. — *Thames R. seasons.* Griffiths, R. Pre-Linn. 1746.1.

Breeding seasons of various fishes. — *Polyodon.* Allen, W. F. 1911.1. — *Cod.* Baird, S. F. 1875.28. — *Variations in Labridæ.* List, J. H. 1887.2. — *Coregonus.* Lochner von Hüttenbach, – 1907.1; Sandman, J. A. 1904.2. — *Black bass.* Wilmot, S. 1876.2.

Copulation. *For actual copulation in teleosts with internal fertilization, Chimæroids, and sharks and rays including oviparous forms, see below under* Viviparity.

Fecundity, or number of eggs produced. *Miscellaneous papers.* Atkins, C. G. 1870.1; Audigé, J. & Loup, — 1909.1; Harmer, T. 1768.1.

Marine fishes, chiefly Gadus morrhua, G. pollachius, Platessa vulgaris, and Pleuronectes platessa. Dunn, M. 1884.2; Earll, R. E. 1880.1; Feldt, — 1899.1; Franz, V. 1910.1,.2; Fulton, T. W. 1906.2; Hensen, V. 1883.1, 1884.1; Hensen, V., & Apstein, C. 1897.1; Laurie, R. D. 1904.1; Reibisch, J. 1899.1.

Fecundity of various other fishes. — *Labrax.* Blanding, W. 1841.1. — *Clupea.* Fulton, T. W. 1904.1; Anon. 458. — *Carp.* Staff, F. 1910.1; Zur Mühlen, M. 1911.17. — *Anguilla (9,000,000 eggs).* Anon. 4. — *Salmon.* Anon. 205.

Methods of estimating number of ovarian ova. ★Fulton, T. W. 1891.4; Reibisch, J. 1899.1. — *For counting of eggs in fish-cultural practises, see* Apparatus and appliances, *under* Pisciculture.

Pseudo-copulation of oviparous fishes. *Siluroids. — Silurus glanis.* Agassiz, J. L. 1856.2. — *Callichthys.* Boecker, W. 1909.1; Carbonnier, P. 1880.2, .3, 1881.2; Eggeling, O., & Ehrenberg, F. 1908.1; Jurgens, W. 1906.1; Vipan, J. A. 1886.1. — *Arius, Auchenipterus, and Os-*

teogeniosus. Day, F. 1875.1; Steindachner, F. 1874.3, 1876.3; Thomas, H. S. 1881.1.

Pseudo-copulation in Callionymus lyra. Holt, E. W. 1898.3; Kent, W. S. 1883.1. —*Cottus gobio.* Surbeck, G. 1900.1,.2.

For pseudo-copulation of Syngnathidæ at time of egg transferral, see Brood-pouch incubation, *below under* Parental care.

For actual copulation in viviparous forms, see Viviparity, *below.*

Sexual maturity. *Relation to age and size in marine fishes.* Calderwood, W. L. 1892.6; Cunningham, J. T. 1891.7; Fulton, T. W. 1892.2; Holt, E. W. 1892.3, 1893.2.

State of maturity in French fishes. Gouriet, E. 1894.3, 1897.1; Sauvage, H. E. 1893.1; Arnoux, E. Add. 1889.1.

For sexual maturity in Eels, see Sexes of eels *under* Anguilla *in* Systematic section.

Spawning and spawning habits of various fishes

Including courtship and other kinds of spawning behavior, oviposition, etc.

Courtship (Liebespiel) of animals including fishes. Marx, A. 1914.1; Pycraft, W. P. 1913.1.

Miscellaneous and general. Björkmann, -1785.1; Canu, E. 1893.2; Damas, D. 1909.2; Dunn, M. 1884.3; Epton, J. 1883.1; Masterman, A. T. 1896.1, 1897.3; Rusconi, M. 1836.1; Schreitmüller, W. 1910.10; ★Strodtmann, S. **1906.1**; Coupin, H. Add. 1913.1.

Oviposition of Amphioxus, a cephalochordate. Marshall, A. M. 1876.1.

CYCLOSTOMATA

Spawning behavior of Petromyzon. Dean, B. & Sumner, F. B. 1897.1; Vejdovský, F. 1893.1. —*Bdellostoma.* Doflein, F. J. 1899.3. —*Lampetra.* Reighard, J. E. 1903.1. —*Brook and lake lampreys.* Gage, S. H. 1893.2.

GANOIDEI

Spawning of — Acipenser. Aleksandrov, K. P. 1909.1, 1910.1; Dean, B. 1893.3; Stone, L. 1901.1. —*Lepidosteus.* Locke, W. M. 1879.1.

SELACHII

Oviposition of shelled eggs of Scyllium canicula and catulus. Bolau, C. C. 1879.1, 1881.1; Coste, J. J. 1867.1; Dambeck, K. 1877.2; Kopsch, F. 1897.1; Meyer, R. 1872.1. —*Chiloscyllium.* Raj, B. S. 1914.1. —*Parascyllium.* Waite, E. R. 1908.1.

See also Oviparity of Elasmobranchii *in this section, and* Egg-cases of Elasmobranchii *under* Ova and Ovum.

TELEOSTEI

For the spawning of Anguilla *and* Salmonidæ *in connection with their migratory habits, see these fishes in the* Systematic section.

Sub-order Acanthopterygii

Spawning of — Perch. Bean, B. A. 1890.4. —*Sole (Solea).* Butler, G. W. 1895.1. —*Pleuronectes.* Fulton, T. W. 1904.7, 1906.2; Herdman, W. A. 1903.4; Storrow, B. 1911.1; Trybom, F. 1903.3; Wahlberg, V. 1901.1. —*Eleotris.* Lehmann, A. 1911.1. —*Trigla.* McIntosh, W. C. 1899.1, 1900.2. —*Bluefish (Pomatomus).* Pierce, H. D. 1883.1, 1884.1. —*Badis.* Pittrich, B. 1907.1. —*Macropode.* Schäfer, P. 1915.3. —*Heterogramma.* Schütz, R. 1912.2. —*Ambassis.* Träber-Klotzsche, G. 1910.1. —*Betta.* Unterberg, J. 1913.1. —*Crenilabrus and Labrax.* Eisig, H. Add. 1884.2.

Sub-order Anacanthini

Spawning of — Gadus (Cod). Ewart, J. C. & Brook, G. 1885.1; Fulton, T. W. 1904.4, 1905.2; Meek, A. 1911.1; Sars, G. O. 1876.1; V. 1905.1; Wahlberg, V. 1901.1. —*Lota.* Levander, G. V. 1903.1. —*Whiting.* Storrow, B. 1913.1. —*Merluccius.* McIntosh, W. C. Add. 1912.1.

Sub-order Haplomi

Spawning behavior of — Haplochilus. Liebig, T. 1912.6. —*Esox.* Walke, E. H. 1883.1; Brook, G. Add. 1887.2; Argillander, A. Pre-Linn. 1753.1,.2. —*Lebistes.* Wind, A. 1915.1.

Sub-order Malacopterygii

Spawning of — Herring. Baird, S. F. 1871.40; Ewart, J. C. 1884.3; Kupffer, C. W. 1876.2, 1878.2; Buch, S. A. Add. 1885.1. —*Sardine.* Launette, P. 1888.1. —*Coregonus.* Lebedintsev, A. A. & Eglit, P. I. 1907.1–1909.1. —*Pantodon.* Siegl, H. 1914.2; Steche, O. 1915.1. —*Alosa (Shad).* Worth, S. G. 1893.1; Yarrow, H. C. 1874.2. —*Mallotus spawning in sand of seashore.* Anon. 512.

Sub-order Ostariophysi

Spawning of — Corydoras. Liebig, T. 1912.5; Wittig, F. 1913.1. —*Danio.* Potempa, A. 1910.2. —*Cyprinidæ.* Reighard, J. E. 1904.1, 1910.1. —*Chub (Mylocheilus).* S., C. A. 1880.1. —*Gobio.* Scholz, E. J. R. 1911.2. —*Carassius.* Schreitmüller, W. 1910.15. —*Chrosomus.* Smith, B. G. 1908.1. —*Cobitis and Phoxinus.* Thumm, J. 1905.2.

Spawning of fishes
of various other sub-orders

Spawning of — Lophius. Baird, S. F. 1871.41. —*Ammodytes.* Fullarton, J. H. 1894.1; McIntosh, W. C. 1897.1. —*Pterophryne.* Gudger, E. W. 1905.2. —*Entelurus æquoreus (eggs extruded in two bands).* Guitel, F. 1908.2. —*Gasterosteus leiurus.* Kinahan, J. R. 1854.1,.2. —*Exocœtus.* Saunders, H. 1874.1.

Spawning Grounds *of North Sea; relation of marine currents.* Fulton, T. W. 1890.7, 1895.3, 1897.1, 1900.1, 1913.1.

Spawning grounds of various fishes. —*Clupea in Kaiser Wilhelm Canal.* Barfod, H. 1902.3; Hinkelmann, A. 1902.2. —*Breeding grounds of Herring.*

Reproduction — *Cont'd.*
Petersen, C. G. J. 1901.2. — *Ammodytes.* Bowman, A. 1914.1. — *Gadus in North Sea.* Giard, A. & Cépède, C. 1907.1; Schmidt, E. J. 1909.1. — *Spawning relationships and places, Gadus.* Anon. 327.

PARENTAL CARE

Of eggs and young

Miscellaneous and general. Belle, — 1910.2; Brandes, G. 1893.2; Brüning, C. 1903.1; Cobb, J. N. 1908.3; Coupin, H. 1901.1; ★Gill, T. N. **1906.3**; Krause, E., & Sterne, C. 1902.1; Laloy, L. 1901.1; Leonhardt, E. E. 1905.6; Rozynski, P. 1909.2; Schreitmüller, W. 1910.10; Werner, Franz. 1900.1; ★Wiedersheim, R. E. 1900.1, 1901.1; Anon. 358, 510; Allen, G. Add. 1890.1.

Attachment of eggs to body of parent}

Abdominal attachment, *by threads in Haplochilus melanostigma.* Jenkins, J. T. 1910.1. — *in H. latipes.* Leonhardt, E. E. 1905.12.

Frontal attachment *by threads to protuberance of head in Kurtus gulliveri.* Guitel, F. 1913.1; Weber, M. C. 1910.1, .2, 1913.3; Zur Mühlen, M. 1911.8.

Ventral attachment, *in cup-shaped depressions in Aspredo.* Günther, A. 1880.4, 1886.2; Vaillant, L. L. 1898.4; Wyman, J. 1859.4.

Ventral attachment in Nerophis, (Syngnathidæ). Andrews, W. 1854.1, 1860.1; Carolini, F. 1787.1–1808.1; Ekström, C. U. 1830.1, 1835.1; Fries, B. F. 1837.2; Krohn, A. D. 1840.1; Lilljeborg, W. 1884.1; Quatrefages, J. 1842.1.

Brood-pouch incubation in Lophobranchii

Sub-caudal pouch in Syngnathidæ. *Males of Hippocampus and Syngnathus.* Andrews, W. 1854.2, 1860.1; Becker, L. 1857.1; Cohn, L. 1903.1; ★Huot, A. **1902.1**; Kolster, R. 1907.2; Krohn, A. D. 1840.1; Krøyer, H. N. 1853.1; Lockwood, S. 1868.1,.2, 1887.1; Siebold, C. T. 1842.1; Yarrell, W. 1834.1, 1835.2,.3; Anon. 473.

Breeding habits, comprising courtship and transferral of eggs to marsupium. Bloch, M. E. 1782.1; Bonnaterre, P. 1788.1; Buchanan, F. 1822.1; Canestrini, G. 1871.1,.2; Cuvier, G. 1836.1; Dufossé, A. 1874.2; Duncker, G. 1900.1; Ekström, C. U. 1830.1, 1835.1; Fanzago, F. 1874.1; Fusari, R. 1895.1; ★Gudger, E. W. **1905.1**; Jacobi, A. 1906.1; Heincke, F. 1880.1; Lafont, A. 1868.1, Add. 1871.1; Lilljeborg, W. 1884.1; Marcusen, J. 1873.1; Petersen, M. 1906.1; Rathke, H. 1837.1; Smitt, F. A. 1893.1; Storer, D. H. 1855.1; Yarrell, W. 1835.2,.3, 1834.1. — *Review of Gudger,* 1905.1. Lydekker, R. Add. 1906.4.

For ventral attachment of eggs without a brood pouch in Nerophis, see above.

Ventral fin pouch of Solenostomidæ, *formed by coalescence of ventral fins to body in females.* Günther, A. 1880.4, 1886.2. Willey, A. 1909.2.

Incubation in gill-cavities of mussels

Bitterling (Rhodeus amarus) breeding in gill-cavities of Anodonta and Unio. Bach, M. 1871.1; Bade, E. 1899.7; Braun, P. 1901.1; Cuénot, L. 1898.1; Maslowsky, A. 1863.1; Mettenheimer, C. 1869.1; Nölke, – & Hagermann, – 1910.1; Noll, F. C. 1869.1, 1870.1, 1877.1; ★Olt, A. **1893.1**; Pagenstecher, H. A. 1869.1; Weismann, A. 1876.1. — *Oviducal tube, structure.* Krauss, F. 1858.1; Leydig, F. 1892.4.

For association of other fishes and molluscs, see Commensalism.

Nest-building or Nidification

Miscellaneous and general. Agassiz, J. L. 1856.2; Bach, M. 1871.1; Couch, R. Q. 1844.2; ★Ehrenbaum, E. **1897.1** (iii); Figuier, G. L. 1858.1; Gill, T. N. 1907.5; Hardy, J. 1845.1; Harting, P. 1875.1; Lengyel, I. 1872.1; Martens, E. 1872.1; Mitchell, R. W. 1875.1; Peneau, J. 1913.1; Putnam, F. W. 1859.2; Surbeck, G. 1908.5,.6; Anon. 225, 382, 397; Holder, C. F. Add. 1883.1; Wood, J. G. Add. 1867.1.

Bird-nest type of nest. *Fixed nest of stickleback (Gasterosteus).* Bade, E. 1899.10; ★Coste, P. 1846.1,.2,.3; Couch, R. Q. 1864.3; Dollfus, E. 1871.1; ★Ehrenbaum, E. **1897.1** (iii); Evers, M. 1878.1, 1879.1, 1880.1; Glaser, L. 1865.1; Hancock, A. 1852.1; Horsfall, J. H. 1864.1; Houghton, W. 1865.1; Johnston, G. 1834.4; Jones, J. E. 1871.1; Kinahan, J. R. 1854.1,.2; Landois, H. 1871.2; Lauppe, L. 1904.1; Möbius, K. A. 1893.1; ★Prince, E. E. **1885.2**; Putnam, F. W. 1859.2; R., G. P. 1866.1; Ransom, W. H. 1865.1; Reitmayer, C. A. 1916.1; Ryder, J. A. 1882.6; Schlesinger, F. W. 1900.1, 1902.1; Wichand, B. 1904.1; Anon. 290, 381, 522, 523; Braun, M. Add. 1890.1; Warington, R. Add. 1852.1. — *Mucous threads of nest derived from kidney secretions of male.* ★Möbius, K. A. **1885.1, 1886.1**.

Floating nests of vegetation with attached eggs. — *Of Gymnarchus niloticus.* Budgett, J. S. 1900.5, 1907.1. — *Labrus.* Gerbe, Z. 1864.1. — *Ophiocephalus striatus.* Willey, A. 1909.1.

Bubble or foam nests. *Nests of Osphromenidæ of foam strengthened by buccal secretions.* Bangerter, H. 1914.1; Carbonnier, P. 1876.1,.2; Emeljanenko, P. E. 1909.2; Engmann, P. 1909.1; Eyrich, L. 1870.1; Gilbert, C. H. 1894.1; Harting, P. 1877.3; Köhler, W. 1908.1; Leonhardt, E. E. 1905.5; Lydekker, R. 1905.1; Meier, H. 1877.1, 1878.1; Melnikov, V. S. 1902.2, 1903.1; Pobowski, E. 1880.1; Roth, W. 1909.1; Schreitmüller, W. 1909.4, 1910.18; Treschow, A. 1908.1; Waite, E. R. 1904.2, 1905.1; Anon. 299, 380.

Foam nest of African characin, Sarcodaces. Budgett, J. S. 1900.5,.7.

Excavated nests. *Formed by excavation of depressions in the mud, sand or gravel of the bottom.* — *Ameiurus.* Agassiz, J. L. 1856.2; Eycleshymer, A. 1901.1; Girard, C. F. 1854.4; Ryder, J. A. 1883.3; Smith, H. M., & Harron, L. G. 1904.1; Smith, H. M. Add. 1903.1.

Amia calva. Dean, B. 1895.2, 1899.4; Franklin, D. 1914.2; Fülleborn, F. 1894.1; Hallock, C. 1877.1; Maison, E. 1897.1,.2; ★Reighard, J. 1900.1, 1901.2, 1902.1, **1904.2**; Whitman, C. O. & Eycleshymer, A. C. 1897.1.

Brook lamprey (Lampetra). Dean, B., & Sumner, F. 1897.1; Gage, S. 1893.2; Reighard, J. E. 1903.1; Young, R. T., & Cole, L. J. 1900.1. — *Sea lamprey (Petromyzon).* Hussakof, L. 1912.6, 1913.3; Wyman, J. 1844.2.

Centrarchidæ. Eupomotis. Agassiz, J. L. 1856.2; Franklin, D. 1914.1; Gill, T. N. Add. 1889.1. — *Micropterus (black bass).* Baird, S. F. 1873.17; Eoff, J. 1855.1; Gill, T. N. 1889.3; Holt, C. F. 1889.1; Lambkin, J. B. 1901.1, 1903.1; Lydell, D. 1903.1–1904.1; ★Reighard, J. E. 1906.1.

Various other fishes.—West African fishes, Heterotis, Hyperopisus, Protopterus. Budgett, J. S. 1900.5, 1907.1. — *Rhinichthys atronasus.* Gregg, W. H. 1879.1. — *Doras.* Hancock, J. 1828.2. — *Lepidosiren.* Kerr, J. G. 1900.1. — *Semotilus atromaculatus.* Reighard, J. E. 1910.1. — *Arius australis.* Semon, R. 1896.2, 1899.1, 1903.1. — *Callichthys.* Vipan, J. 1886.1. — *Semotilus corporalis, stone heaps in Ottawa River.* Wilson, A. W. 1907.1; Bell, R. Add. 1897.1.

Pelagic "nests," *composed of gelatinous bands with imbedded eggs, generally entangled in sea-weed.* — *Of Kelpfish (Heterostichus).* Holder, C. F. 1907.1.

Nests of Antennariidæ, Antennarius or Chironectes, drifting among Sargassum weed. ★Agassiz, J. 1872.1, 1873.2; Baird, S. F. 1871.41, 1872.2; Geare, R. I. 1903.2; Goode, G. B. 1876.2; Gudger, E. W. 1905.2; Hinde, G. J. 1872.1; Jones, J. M. 1872.1; Martens, E. 1872.1; ★Möbius, K. A. 1894.1; Thomson, C. W. 1877.1; ★Vaillant, L. L. 1887.3; Jones, S. G. Add. 1884.1. — *Not a nest-maker.* Gill, T. N. 1905.13, 1907.7.

For description of floating "rafts" of eggs of Lophius and other types of Pelagic ova, *see under* Planktonic fauna.

Unformed "nests," *being merely selection of sheltered sites with egg deposition and subsequent guarding by the adult fish.*

Blennies, — Blennius. Cunningham, J. T. 1889.4; Guitel, F. 1893.2,.3; Pieron, H. 1914.1. — *Pholis gunnellus.* Ehrenbaum, E. 1897.1 (iii); Holt, E. W. 1893.4; McIntosh, W. & Prince, E. 1890.1. — *Clinus argentatus.* Guitel, F. 1892.2, 1893.2.

Cottus (Miller's Thumb). Ehrenbaum, E. 1897.1 (iii); Gill, T. N. 1905.15, 1908.2; Le Danois, E. 1911.1; McIntosh, W. C. 1897.1; Meek, A. 1915.5; Peek, R. 1869.1; Peck, T. Add. 1869.1.

Cyclopterus (Lumpfish). Bonnaterre, P. 1788.1; Ehrenbaum, E. 1897.1 (iii); Fulton, T. W. 1906.3; Gill, T. N. 1907.3; McIntosh, W. C. 1886.4, 1897.1.

Gobius. Filippi, F. 1841.1,.2; Guitel, F. 1892.1, 1895.1; Holt, E. W. 1890.3; Petersen, C. G. 1891.3, Add. 1892.1; Saint-Joseph, — 1881.1, 1893.1.

Lepadogaster. Guitel, F. 1888.1, 1890.6; McIntosh, W. C. 1897.1; Smith, W. A. Add. 1885.1.

Toadfishes, Opsanus and Porichthys. Gill, T. N. 1907.2; Greene, C. W. 1899.1; ★Gudger, E. W. **1910.1**; Ryder, J. A. 1886.3; Storer, D. H. 1855.1.

Oral gestation

Miscellaneous and general. Boettger, D. 1902.1; Gill, T. N. 1906.3; Gudger, E. W. 1909.1; Hutchinson, R. F. 1880.1; Newman, E. 1860.3; ★Pellegrin, J. **1904.2**, 1907.2, Add. 1907.1; Potempa, A. 1909.1; ★Anon. **677**, 683; Boulenger, G. A. Add. 1902.1,.2, 1909.2; Sachs, E. T. Add. 1881.1.

Alleged oral gestation (*Considered doubtful or already disproved.*) — *In Amia calva.* Reighard, J. 1904.2; Whitman, C. O., & Eycleshymer, A. C. 1897.1; Estes, D. C. Add. 1887.1. — *Malopterurus.* Babukhin, A. I. 1875.1, 1877.1; Boulenger, G. A. 1901.22, 1907.15; Fritsch, G. T. 1887.1. — *Loricaria.* Agassiz, J. L. 1868.1; Ihering, H. 1893.2; Regan, C. T. 1904.6. — *Gymnotus electricus.* Du Bois-Reymond, E. H. 1882.2; Sachs, C. 1881.1; Spix, J. B., & Martius, C. F. 1823.1. — *Betta pugnax.* Hipler, J. 1913.1,.2. — *Various Brazilian fishes.* Monteiro de Noronha, J. Add. 1841.1.

Chilodipterinæ. (*Serranidæ*), *Apogon (Amia).* Kendall, W. C., & Radcliffe, L. 1912.1; Radcliffe, L. 1911.1, 1912.1; Regan, C. T. 1902.2; Vaillant, L. 1903.1; Steindachner, F. & Döderlein, L. 1883.1; Weber, M. 1913.1; Boulenger, G. A. Add. 1902.1; Ogilby, J. D. Add. 1889.1; Smith, H. M. Add. 1910.1; Stead, D. G. Add. 1906.1, 1907.5. — *Archamia.* Evermann, B. W., & Seale, A. 1907.1.

Cichlidæ. *General.* Dreyzehner, — 1909.1; Emeljanenko, P. W. 1910.1; ★Pellegrin, J. **1904.2.**

African Cichlidæ of numerous genera. Abraham, N. 1901.1; Boulenger, C. L. 1908.1; Boulenger, G. A. 1898.15, 1899.14, 1900.18, 1901.22, 1906.5,.6, 1907.15, 1908.1, Add. 1909.1, 1902.1; Conrad, — 1908.1; Cornet, J. 1893.1; Engmann, P. 1905.2; Flieszbach, O. 1901.1, 1903.1, Add. 1907.1; Geidies, H. 1912.1; Gruber, A. 1911.2; Günther, A. C. 1901.2; Köhler, W. 1903.1; Moore, J. E. 1902.1; ★Pellegrin, J. **1904.2,** 1906.4,.5, 1907.17, 1909.7, 1910.1; ★Schoeller, C. H. 1903.1;

Reproduction — *Cont'd.*
Schreitmüller, W. 1912.7; Weber, M. 1897.1; Supino, F. Add. 1910.1.

Syrian Cichlidæ of Jordan R. system. Boulenger, G. A. 1898.15; ★Lortet, L. 1875.1,.2, **1883.1;** Lubach, D. 1876.1; Pellegrin, J. 1904.2, 1905.2; Masterman, E. W. Add. 1908.1, 1909.1.

South American Cichlidæ, chiefly Geophagus. Agassiz, J. L. 1865.1; ★Agassiz, J. L., & Agassiz, E. 1868.1; Eigenmann, C. H. 1912.2; Engmann, P. 1903.1; Gill, T. N. 1909.3; Harting, P. 1866.3; Haseman, J. D. 1911.2; Hensel, R. 1870.1; Orton, J. 1870.1; Pellegrin, J. 1904.2; Putnam, F. W. 1865.9, Add. 1863.1; Coutinho, J. M. Add. 1866.1.

Osteoglossidæ. *Arapaima.* Castelnau, F. L. 1855.1; Du Bois-Reymond, E. 1882.2; Ferreira, A. R. 1903.1; Schomburgk, R. H. 1841.1; Spix, J. B., & Martius, C. F. 1823.1; Monteiro de Noronha, J. Add. 1841.1. — *Osteoglossum.* Haseman, J. D. 1911.2. — *Scleropages.* Fuhrmann, O. 1905.1,.3,.6, 1906.3, Add. 1905.1; Boulenger, G. A. Add. 1909.2, 1911.1.

Siluridæ. *Earliest references to oral gestation in Silurids of unknown habitat.* Bloch, M. E. 1785.1,.2; Bloch, M., & Schneider, J. 1801.1.

African Galeichthys. Boulenger, G. A. 1891.2.

Indian and Ceylon forms. Boake, B. 1866.1; Day, F. 1873.4, 1875.1, 1876.1, 1889.1, Add. 1885.1; Günther, A. 1866.1, 1880.4; Jenkins, J. T. 1910.1; Perrier, E. 1903.1; Thomas, H. S. 1881.1; Turner, W. 1867.1; Willey, A. 1910.1, Add. 1909.1; Boulenger, G. A. Add. 1909.2.

Indo-Australian forms, chiefly Australia and New Guinea. Kampen, P. N. 1910.1; Ramsay, E. P., & Ogilby, J. D. 1886.1; Stead, D. G. 1906.1, 1908.1, Add. 1907.5; Woods, J. E. 1888.1; Albertis, L. M. Add. 1881.1; Boulenger, G. A. Add. 1902.1.

North American marine forms. — *Conorynchos nelsoni of Yucatan.* Evermann, B. W., & Goldsborough, E. L. 1902.1,.3; Meek, S. E. 1904.1. — *Felichthys felis.* Clarke, S. C. 1884.1, Add. 1883.1; Goode, G. B. 1888.1, 1903.1; Gudger, E. W. 1908.1, 1912.3; Henshall, J. A. 1895.1; Holder, C. F. 1904.1; Jenkins, O. P. 1887.2; Ryder, J. A. 1883.3, 1887.2; *see also* ★Gudger, E. W. *in* Pub. 252, Carnegie Instit. Wash., 1918. — *Galeichthys milberti.* Hallock, C. 1877.1; Lupton, N. T. 1877.1–1880.1; Ryder, J. A. 1883.3, 1887.2; Smith, H. M. 1907.1. — *Netuma of Panama.* Gilbert, C. H., & Starks, E. C. 1904.1; Steindachner, F. 1876.3.

South American forms, chiefly from Brazil and British Guiana. Appun, K. F. 1870.1; Castelnau, F. L. 1855.1; Dalton, H. G. 1855.1; Günther, A. 1859.1; Haseman, J. D. 1911.2; Hensel, R. 1868.1, 1870.1; Ihering, H. 1888.1, 1897.1, Add. 1885.1; Martin, M. 1834.1; Pellegrin, J. 1907.16, 1908.5; Schomburgk, R. H. 1841.1; Wyman, J. 1859.4,.6; Alexander, J. E. Add. 1832.1; Green, J. Add. 1858.1; Hillhouse, W. Add. 1825.1; Schomburgk, M. R. Add. 1847.1.

Various fishes. *Amblyopsis spelæus.* Eigenmann, C. H. 1900.1, 1909.2. — *Trematomus berrnacchi.* Pellegrin, J. 1904.2. — *Luciocephalus pulcher.* Volz, W. 1904.1. — *Anabas multispinis.* Boulenger, G. A. Add. 1911.1.

OVIPARITY OF ELASMOBRANCHII

Oviparous reproduction by shelled eggs in sharks and rays. — *General accounts.* ★Müller, J. 1840.1, 1842.3; Tilesius von Tilenau, W. 1802.1.

Oviparity in the following Elasmobranchs including descriptions of their eggs and embryos. — *Myliobatis.* Couch, J. 1847.2. — *Chimæra.* Dean, B. 1906.1. — *Somniosus.* Lütken, C. F. 1880.2. — *Callorhynchus antarcticus.* Parker, T. J. 1882.5, Add. 1884.2. — *Skates.* Putnam, F. W. 1870.8.

See also Oviposition of shelled eggs of Selachii *in this section, and* Egg-cases of Elasmobranchii *under* Ova and Ovum.

OVOVIVIPARITY

Ginglymostoma. Gudger, E. W. 1913.5, Add. 1912.2, 1913.1, 1914.2.

VIVIPARITY

Miscellaneous and general. Adams, A. 1863.1; Agassiz, J. L. 1856.10; Balbiani, E. G. 1886.1; Eigenmann, C. H. 1899.9; Emeljanenko, P. E. 1907.1; Lubach, D. 1866.2; Osburn, R. C. 1912.3; Ringel, E. 1911.1; ★Ryder, J. A. 1886.7; Anon. 332; Sterne, C. Add. 1901.1. — Pre-Linn. *ref.* Grew, N. 1681.1.

Evolution of viviparity, theory based on Characodon. Philippi, E. 1906.2.

Oviducal or uterine gestation of Elasmobranchs

Miscellaneous items. Agassiz, J. L. 1856.7,.8; Batarra, G. 1771.2; Blackford, E. G. 1880.1; Coles, R. J. 1910.1, 1913.1; Gudger, E. W. 1912.2; Lesseps, F. M. 1874.1; Lovejoy, J. F. 1880.1; Mitchill, S. L. 1803.1; Oerley, L. 1885.2, .4; Pearson, J. T. 1835.1; Stearns, S. 1878.1; Flourens, M. J. Add. 1836.1, 1838.1; Geoffroy, C. Pre-Linn. 1721.1. — *First reference.* Aristotle, Pre-Linn. 1476.1.

Presence in Squalus and Spinax, of a prenatal knob on dorsal spine to prevent cutting mother. Ball, R. 1847.1; Koppen, H. 1901.1; Markert, F. 1896.1. — *Parturition in Pristiurus.* Borcéa, J. 1908.1. — *Fat content of Selachian liver during pregnancy.* Polimanti, O. 1912.6. — *Implantation of selachian ovum in spleen.* Gargano, C. Add. 1914.1.

Copulatory organs (Myxopterygia) and their use; *including oviparous forms.*

Manner of copulation in sharks and rays. Agassiz, J. L. 1858.10, 1871.1; ★Bolau,

C. C. 1881.1; Dambeck, K. 1877.2; Gudger, E. W. 1913.5; Raj, B. S. 1914.1; Robson, C. H. 1884.1; Schneider, A. F. 1883.1.

Fossilized remains of claspers in Cetorhinus and Pleuracanthus. Beneden, P. J. 1876.1,.2; Fritsch, A. J. 1890.3, 1895.1. —*Chimæroids.* Woodward, A. S. 1889.2, 1906.3.

Frontal claspers in Chimæroids. Dean, B. 1906.1.

Morphology of the claspers or myxopterygia. Albrecht, P. 1886.2; Bloch, M. E. 1785.4, 1788.1; Costa, O. G. 1861.1; Davidoff, M. 1879.1; Davy, J. 1839.1, 1861.1; Garman, S. 1877.2; ★Gegenbaur, C. **1870.4**,.5, 1876.1; Gunner, J. E. 1763.1; ★Huber, O. **1901.1**,.2, 1908.1; ★Jungersen, H. F. **1898.2**,.3, Add. **1899.1**; ★Krall, A. **1908.1**; Mayer, A. F. 1834.1, 1842.1; Ostroumov, A. A. (*Phylogeny*) 1893.1; Parker, T. J. 1886.2; ★Petri, K. R. 1878.1; Putnam, F. W., & Garman, S. W. 1874.1; Stannius, F. H. 1840.1; Treviranus, G. R. 1826.1,.2; Vogt, C. C., & Pappenheim, S. 1859.1; Haswell, W. A. Add. 1884.1.—*Shown to be copulatory organs.* Agassiz, J. L. 1858.9,.10.—*Early ref.* Klein, J. T. Pre-Linn. 1740.1.

"Gland" of clasper, anatomy, etc. Home, E. 1809.1, 1810.1, 1813.1; Jungersen, H. E. 1898.2,.3, Add. 1899.1; Molin, R. 1853.1, 1859.1; Smith, (*Sir*) A. 1829.1, 1849.1.

For a recent paper on claspers, gland, etc., see ★Leigh-Sharpe, W. H. *in* Journ. Morphology, 1920, *vol.* 34, *pp.* 245–265; 1921, *vol.* 35, *pp.* 359–378; 1922, *vol.* 36, *pp.* 191–244, *ills.*

Foetal membranes. *Pseudamnion, a thin, transparent membrane, the homologue of the horny egg-case of oviparous forms.* Evant, T. 1904.1,.2; Gudger, E. W. 1912.1.—*Mustelus.* Parker, T. J. 1882.4, 1890.1.

Numerous embryos in a single envelope; Rhinobatus and Trygonorhina. Haacke, J. W. 1885.2, Add. 1886.1.—*Discussion of this.* Jungersen, H. F. 1885.1.

An analysis of the pseudo-amniotic fluid. Liversidge, A. Add. 1890.1.

Nourishment of embryo in Selachii.

Nourishment by means of external gills, acting as placentæ. Alcock, A. W. 1890.2, 1892.4; ★Clemens, P. 1895.1; Home, E. 1810.1, 1816.3; Jacobson, L. L. 1834.1; Leuckart, F. S. 1836.1; Lubach, D. 1870.1; Rathke, M. H. 1827.1; Schenk, S. L. 1875.1; Macartney, J. Add. 1818.1; Owen, R. Add. 1833.1.

For the structure and development of the external gills in Selachii, see False External Gills *under* Respiratory System.

Yolk-sac-placenta formation in sharks. Ercolani, G. B. 1879.1; Leydig, F. 1852.1; ★Mehrdorf, C. 1890.1; ★Müller, J. 1842.3.

See also Yolk Sac *and* Umbilical Cord, *under* Embryology.

Dorsi-ventral expansion of tail of embryo Pteroplatea, probably functioning as an absorptive surface. Gudger, E. W. 1911.1.

Uterus. *Structure.* ★Bruch, E. 1860.1. —*Condition before first gestation.* Blaizot, L. 1908.1,.2.—*Mucosa, histology.* Brinkmann, M. C. 1903.1.—*Musculus sphincter uterorum.* Widakowich, V. 1907.2, 1908.1. —*Internal structure.* Leydig, F. Add. 1857.1.

Uterine villi or trophonemata, structure, relation to embryo, etc. Gudger, E. W. 1912.2, 1913.3; Lönnberg, A. J. 1902.2; Trois, E. F. 1867.1, 1876.6; Widakowich, V. 1907.1; ★Wood-Mason, J., & Alcock, A. 1891.2, 1892.1; Carus, C., Otto, A., & D'Alton, E. Add. 1828.1.

Viviparity, *general accounts.* ★Alcock, A. W. 1890.2, 1901.1, 1902.1; Gudger, E. W. 1912.2; Home, E. 1810.1, 1816.3; Mitchell, S. L. 1803.1; ★Müller, J. 1840.1, 1842.1, **1842.3**; Müller, J., & Henle, J. 1841.1; Tilesius von Tilenau, W. G. 1802.1.

Figures of embryos of various species. ★Garman, S. 1913.1.

Viviparity in the following sharks and rays, including in some cases descriptions of their intra-uterine embryos.

Sharks

Acanthias. Garman, S. 1913.1; Leidy, J. 1865.1; Leuckart, F. S. 1831.1; Sauvage, H. E. 1888.4; Wyman, J. 1848.1.

Chlamydoselachus. Brohmer, P. 1909.1; Dean, B. 1903.6; Garman, S. 1913.1; Nishikawa, T. 1898.1; Ziegler, H. E. 1908.1.

Galeus. ★Müller, J. 1840.1, **1842.3**; Peabody, J. E. 1896.1.

Lamna. Calderwood, W. L. 1887.1; Lohberger, J. 1910.1; Shann, E. W. 1911.1; Swenander, G. 1907.1.

Pristiophorus. Haswell, W. A. 1885.1, Add. 1889.1; Stead, D. G. 1906.2.

Pristis. Hussakof, L. 1912.3; Southwell, T. 1910.2.

Zygæna. Cantor, T. E. 1845.1; Gudger, E. W. 1912.1; Leuckart, F. S. 1836.1; Wyman, J. 1856.4.

Viviparity in—*Galeorhinus.* Garman, S. 1913.1. —*Scoliodon.* Gudger, E. W. 1915.3. —*Scymnus.* Parker, T. J. 1882.1. —*Carcharodon.* Sanzo, L. 1910.1. —*Oxyrhina.* Vaillant, L. L. 1889.1. —*Squalus.* Zouiev, B. 1787.1. —*Centrina.* Carus, C. G., Otto, A. W. & D'Alton, E. Add. 1828.1.

Rays

Aetobatus. Coles, R. J. 1910.1, 1913.1; Gudger, E. W. 1914.1; Klunzinger, C. B. 1871.1.

Narcacion and Rhina. Garman, S. 1913.1.

Narcine. Bean, B. A. & Weed, A. C. 1911.1; Garman, S. 1913.1.

Pteroplatea. Alcock, A. W. 1892.5. —*Pteroplatea and Dasyatis.* Gudger, E. W. 1910.1, 1911.1, 1912.2, 1913.3.

Reproduction — *Cont'd.*

Rhinoptera. Bleeker, P. 1852.11; Coles, R. J. 1913.1; Gudger, E. W. 1912.1.

Torpedo. Emmert, J. 1900.1; Leuckart, R. 1850.1.

Trygon. Alcock, A. 1892.4. — *Trygon and Urolophus.* Haswell, W. A. Add. 1889.1.

Ovarian gestation of Teleosts

Alleged viviparity. — *Gadidæ.* Agassiz, J. L. 1856.11. — *Arapaima.* Castelnau, F. L. 1855.1. — *Malopterurus.* Fritsch, G. T. 1887.1. — *Rhodeus.* Jeitteles, B. J. 1862.2. — *Cyprinodon.* Lortet, L. 1883.1. — *Fundulus.* Newman, H. H. 1909.2. — *Mola.* Pembroke, — 1872.2. — *Luciocephalus.* Reichelt, J. Add. 1906.1. — *Gymnotus.* Sachs, C. 1881.1. — *Osphromenus.* Hardwicke, T. 1829.1; Reichelt, J. Add. 1906.1; Artaud, J. Add. 1827.1.

Various Siluroids. — East Indian. Bleeker, P. 1858.8. — *Galeichthys.* Evermann, B. W., & Bean, B. A. 1896.1. — *Arius.* Thurston, E. 1900.1. — *British Guiana forms.* Appun, K. F. 1870.1; Schomburgk, R. H. 1841.1; Hillhouse, W. Add. 1825.1.

Blenniidæ. *Clinus despicillatus.* Rauther, M. 1909.1; Günther, A. 1876.3; Johnston, R. M. Add. 1883.2. — *Unidentified blenny from Australia.* Becker, L. 1857.2.

Comephoridæ. *Comephorus baicalensis.* Zograf, N. Y. 1901.2, 1902.2. — *Death after parturition.* Dybowski, B. I. 1873.1, 1901.1.

Cyprinidæ. *Barbus viviparus.* Weber, M. 1897.1.

Embiotocidæ. Agassiz, J. L. 1853.4, 1854.1; Alzate y Ramyrez, J. A. 1772.1, 1773.1; Blake, J. H. 1867.1–1869.1; ★Eigenmann, C. H. **1894.4**, 1895.1, 1896.4; Girard, C. F. 1856.7, 1859.1, 1890.2; Jackson, A. C. 1853.1; Lambert, G. 1895.1; Lord, J. K. 1867.5; Mitchell, G. L. 1899.1; Ryder, J. A. 1885.4, 1886.7, 1893.2; Anon. 210, 568. — *Mating habits.* Randolph, P. B. 1898.1. — *Vascular respiratory mechanism of the vertical fins.* Ryder, J. A. 1893.2.

Ophidiidæ. *Various genera from the Indian Ocean.* Alcock, A. W. 1891.1, 1895.1, 1898.1, 1901.1.

Poeciliidæ. *Miscellaneous and general.* Agassiz, J. L. 1853.6,.9, 1858.5; Dowler, B. 1855.1; Duvernoy, M. 1844.1; Fitzgerald, C. 1872.1; Stansch, K. 1911.6, 1914.1; Wichand, B. 1906.1.

Morphology of intromittent organ (anal fin) of male. Bade, E. 1904.1; Henn, A. W. 1916.1; ★Langer, W. F. **1913.1**; Regan, C. T. 1913.18.

The intromittent organ of Anableps possesses a dextral or sinistral structure, presumed by Garman to require mating with an opposite type of female and thus cause cross-fertilization. Garman, S. 1895.1,.2, 1896.1; Martens, E. 1896.2.

Phallostethus, the only known viviparous Pœciliid not American, possesses an intromittent organ which is formed from the modified ventral fins. Regan, C. T. 1913.14.

Viviparity in various genera. — Anableps. Bloch, M. E. 1785.2; Garman, S. 1895.1,.2, 1896.1; Lacépède, B. G. 1798.1; Ryder, J. A. 1886.7; Wyman, J. 1856.1, 1859.1. — *Characodon.* Philippi, E. 1906.2. — *Cnesterodon.* Brandes, G. 1900.1; Matte, P. 1900.1; ★Philippi, E. 1906.1, **1908.1**, 1908.2; Zolotniskii, N. F. 1901.1,.2, 1903.1; Liebe, W. Add. 1914.1. — *Gambusia.* Ryder, J. A. 1882.11, 1886.7, Add. 1884.1; Seal, W. P. 1911.1; Smith, H. M. 1912.5; Stollreither, A. 1914.1; ★Kuntz, A. Add. 1914.2. — *Girardinus.* Boulenger, E. G. 1912.1; Ihering, H. 1883.1; Langner, A. 1910.1; Lorang, C. 1912.2; Perugia, A. 1891.1; Stüve, H. 1901.1. — *Jordanella.* Mayer, A. 1914.1. — *Molliensia.* Schroot, W. 1903.1. — *Xiphophorus.* Weyenbergh, H. 1872.1, 1874.1, 1878.1. — *Zygonectes.* Ryder, J. A. 1881.1.

Duration of pregnancy in Lebistes reticulatus is about one month at 25° C. and more than three months at 18° C. Johs. Schmidt *in* Journ. of Genetics, 1919, vol. 8, p. 150.

Parturition in various forms. Seal, W. P. 1911.1; Schiche, E. 1915.1; Schulz, F. 1904.1; Strieker, M. 1906.2; Weyenbergh, H. 1878.2; Wind, A. 1915.1.

Scombresocidæ. *Hemirhamphus.* Peters, W. C. 1866.2,.4.

Scorpaenidæ, *chiefly Sebastes marinus.* Eigenmann, C. H. 1893.3, 1894.5; Ryder, J. A. 1887.4; Williamson, H. C. 1911.4.

Zoarcidæ. *"Blenny," Zoarces viviparus.* Bambeke, C. 1888.1; Bloch, M. E. 1782.1; Blum, J. 1882.1; McIntosh, W. C. 1885.2; ★Stuhlmann, F. L. 1887.1; Wallace, W. 1903.1; Rathke, M. H. Add. 1833.1. — *Embryonic nutrition.* Kolster, R. 1905.1.

Cuban forms (Brotulidæ), Lucifuga and Stygicola. Lane, H. H. 1903.1, 1908.1, 1909.1.

RESPIRATION

For comprehensive general treatises on respiration, see ★Bakák, E. Add. **1912.1;** ★Winterstein, H. Add. 1912.1.

Aerial respiration

Air breathing by fishes

Miscellaneous papers. Allen, G. 1885.1; Harting, P. 1878.3; Oswald, F. 1907.1; Roth, W. 1905.1. — *Necessity in formation of coprolites.* Vaillant, L. L. 1896.6.

By means of air-bladder *functioning as a respiratory organ.*

Aerial respiration in the lung-fishes or Dipnoi. Dubois, R. 1891.1, 1892.1; Duméril, A. H. 1870.1,.6; ★Oppel, A. Add. 1905.1.

Respiration in Amia calva. Duméril, A. H. 1870.1,.6; Stauffer, J. 1879.2; Wilder, B. G. 1876.2, 1877.1, 1878.1,.3.

Respiratory function of air bladder in Lepidosteus. ★Mark, E. L. 1890.1.

See also under Dipnoi (Ceratodus, Lepidosiren *and* Protopterus) *and* Ganoidei, (Amia *and* Lepidosteus), Natural History.

Aerial respiration in various Teleostei, — Umbra. Brimley, C. S. 1896.1; ★Rauther, M. 1914.1. —*Gymnarchus.* Duvernoy, G. L. 1853.1; Erdl, M. P. 1847.2; Förg, – 1853.1. —*Erythrinus and Sudis.* Jobert, C. 1878.1.

Air bladder, as reservoir of oxygen when fish is in stagnant water. Moreau, F. A. 1876.3.

By means of wall of intestine. — *Brazilian Siluridæ.* Edwards, H. M. 1878.1; Jobert, C. 1877.1, 1878.1; Brüning, C. Add. 1914.4. —*Monopterus.* Volz, W. 1905.1,.4,.5, 1906.1.

Intestinal respiration in the European loach, Misgurnus (*Cobitis*). Babák, E. 1907.1, 1914.1; ★Baumert, F. M. 1853.1,.2; Bischof, C. G. 1818.1; Calugareanu, D. 1907.1; Erman, P. 1808.1; Lupu, H. 1910.1; Anon. 67.

By labyrinthiform and accessory respiratory organs *of various types.*

Various papers, observations, on Indian fishes, etc. Bade, E. 1912.2; Carbonnier, P. 1874.4; ★Day, F. 1868.3, 1877.3; ★Dobson, G. E. 1874.1; Grigorian, C. 1901.1; Harting, P. 1877.2; Semper, C. Add. 1895.1.

For the highly complicated structure of the labyrinthiform organs and related structures, see Accessory branchial organs *under* Respiratory organs.

Branchial or gill respiration

General treatises on respiration of fishes. Flourens, M. J. 1844.1; Kuiper, T. 1907.1.

Respiration as a factor in locomotion. Brugmans, S. J. 1812.1. —*Relation to phosphorescence.* Pflüger, E. F. 1875.1,.2. —*Alleged importance of water as a respiratory stimulus.* Rynberk, G. A. 1911.1,.2.

Influence of age, temperature and size on respiration. Babák, E. & Hepner, J. 1912.1; Baird, S. F. 1873.35; Polimanti, O. 1912.2; Zuntz, N. 1914.1,.2; Ege, R. & Krogh, A. Add. 1914.1; Gardner, J. A. & Leetham, C. Add. 1914.1.

Miscellaneous accounts of respiration in fishes, unimportant papers, notes, etc. Babák, E. 1911.1, 1912.1; Baird, S. F. 1872.23; Bataillon, E. 1896.1,.2; Bert, P. 1869.2; Bohn, G. 1903.1; Broussonet, P. M. 1785.1; Camus, L. & Nicloux, M. 1903.1; Carradori, G. 1799.1; Duméril, A. M. 1807.1,.2; Frédéricq, L. 1891.1; Galton, J. C. 1871.1; Harting, P. 1870.1, 1873.1; Jobert, C. 1877.2, 1878.2; Loewy, – 1909.1; Lovén, S. L. 1830.1; Osburn, R. C. 1911.5; Quinquand, E. 1873.1; Reuter, F. 1909.1; Richet, C. R. 1880.1; Sacy, A. I. 1791.1; Spallanzani, L. 1803.1; Anon. 65, 551, 552; Camerarius, J. R. Add. 1760.1; Carcani, P. Add. 1791.1; Carradori, G. Add. 1794.1; Duméril, C. Add. 1807.1; Fischer von Waldheim, G. Add. 1801.1; Holzfuss, E. Add. 1914.1; Jolyet, F. Add. 1880.1; Lafont, A. Add. 1868.1; Volta, G. S. Add. 1838.1.

Early papers on respiration, in Pre-Linn. *section.* Bartholinus, C. 1700.1; Bartholomæus 1647.1; Bernhardi, F. 1656.1; Camerarius, J. R. 1624.1; Eccard 1637.1; Katzbeccius, G. 1609.1; Klein, J. T. 1740.1; Needham, W. 1667.1; Severinus, M. A. 1659.1; Theophrastus 1479.1.

Physiology of respiration, *comprising general chemical and physical researches.*

For a résumé of the more recent work on the physico-chemical processes involved in respiration, see ★Winterstein, H. Add. **1912.1**.

Important technical papers on the physiology of respiration. ★Bounhiol, J. P. 1904.1, 1905.1, **1905.12,** 1906.1; Duncan, C. & Hoppe-Seyler, F. 1892.1; Gage, S. H. 1892.1; ★Gréhant, L. F. 1869.1, 1870.1, 1871.1; Jolyet, F. 1879.1, 1880.1; Jolyet, F. & Regnard, P. 1877.1; Montuori, A. 1913.1; Provençal, – & Humboldt, F. 1809.1; Regnard, P. & Blanchard, R. 1883.1; Regnault, V., Reiset, J. & Millon, E. 1848.1; ★Rynberk, G. A. 1905.4, 1906.1; Schoenlein, K. 1895.1; Trendelenburg, P. 1912.1; Winterstein, H. 1908.1; Ishihara, M. Add. 1906.1.

Permeability of branchial membranes to salt solutions, in its relation to respiration. Frédéricq, L. 1901.2; Hyde, I. H. 1908.1, 1909.1; Scott, G. C. & White, G. F. 1910.1; Backman, E. L. Add. 1914.1.

Respiratory mechanism in fishes

For comprehensive treatises on the mechanism of respiration, see ★Baglioni, S. **1907.1,** 1908.2; *and* ★Oppel, A. Add. **1905.1,** 1906.1.

General. Duvernoy, G. L. 1839.1,.2; Flourens, M. J. 1830.1; ★Holmquist, O. 1910.1.

Respiratory center, situated in the medulla oblongata. Experiments to determine localization. Babák, E. 1914.1; ★Hyde, I. H. 1904.1; Steiner, J. 1888.1; Vulpian, E. F. 1886.2.

Respiratory mechanism in Petromyzon. Couvreur, E. 1898.1; ★Dawson, Jean 1904.1, 1905.1; Oken, L. 1821.1, 1829.2.

Mechanism in Elasmobranchii. Couvreur, E. (*Torpedo*) 1902.1, 1903.1; Darbishire, A. D. 1907.1; Vaillant, L. L. (*Mobula*) 1912.1.

For respiration of fœtal sharks by means of external gills see Nourishment of embryo *under* Viviparity *in section on* Reproduction.

Respiratory mechanism in Teleostei. Kuiper, T. 1906.1. —*Blenniidæ and Pholis.* Kneeland, S. 1862.1. —*Syngnathus.* Lichtenstein, M. H. 1836.1. —*Mugil.* Molin, R. 1853.3. —*Ammodytes.* Pieri, J. B. 1896.1. —*Carassius.* Westerlund, A. 1906.1.

Vascular respiratory mechanism of the vertical fins of embryonic Embiotocidæ. Ryder, J. A. 1893.2.

Respiratory movement of the branchial apparatus. For a comprehensive review of the literature of this subject see ★Baglioni, S. **1910.2.**

Respiration— *Cont'd.*

General papers. Babák, E. & Dedek, B. 1907.1, 1908.1; Bjelooussow, N. 1901.1; McKendrick, J. G. 1879.1; Mines, G. R. 1913.2; Varigny, H. C. 1892.1.

Technical researches. — Synchronism of respiratory movements with heart rhythm in embryos. Babák, E. & Hepner, J. 1912.1. *— Nervous regulation of respiratory rhythm.* Deganello, U. 1907.1–1908.1. *— Theory of origin of respiratory movements.* Lombroso, U. 1907.1–1908.2; Anon. 582.

"Yawning," in fishes, a respiratory act. Cocks, A. H. 1910.1; Elmhirst, R. 1910.1.

Caudal and cutaneous respiration

Ability to live by cutaneous respiration alone. Babák, E. 1914.1.

Caudal respiration in various fishes. Baumert, F. M. 1853.2.

Diminished resistance against silver salts in fishes with cutaneous respiration. Pigorini, L. 1907.1.

Caudal respiration in Periophthalmus. Haddon, A. C. Add. 1889.1; Hickson, S. J. Add. 1889.1.

ASPHYXIATION

Through respiratory interruption

Effects of asphyxiation on heart and muscles. ★Polimanti, O. 1912.5, 1914.1.

Asphyxiation produced in water deprived of oxygen through boiling or by use of air-pump. Dissard, A. 1898.1; Gréhant, L. F. & Picard, – 1873.1; Boyle, R. Pre-Linn. 1670.2; Hauksbee, F. Pre-Linn. 1712.1.

Observations on the vitality or duration of life of fishes after removal from the water. Bert, P. 1868.1; Dissard, A. 1898.1; Evermann, B. W. 1913.2; Noé, J. 1893.1; Poluta, G. 1865.1; Schüz, E. 1866.1; Anon. 150, 333.

Asphyxiation produced by excess of carbon dioxide. Reuss, H. 1909.1,.2. *— Suffocation in water of marshes.* Rouget, C. 1868.1.

Asphyxiation caused by organic materials in water. Perrier, L. & Labatut, – 1900.1. *— For other papers of a similar nature, see under* Pollution of Streams *under* Fisheries.

RESPIRATORY ORGANS

ACCESSORY RESPIRATORY STRUCTURES

Non-vascular in nature

Atrial chamber or peribranchial cavity in Amphioxus. Development, etc. Lankester, E. R. 1898.1; Lankester, E. R. & Willey, A. 1890.1; Legros, R. 1909.1; Willey, A. Add. 1890.1.

Opercular terminal membrane of Teleosts, aid in respiration. François-Franck, C. A. 1906.1,.3.

Pre-branchial appendages in Dicerobatis (Cephaloptera) consisting of elongated lamellæ functioning to retard the flow of water and thus aid in respiration. Duméril, A. H. 1870.4,.5; Panceri, P. & Sanctis, L. 1869.1.

Serrulæ or serrated throat appendages, possible respiratory function of, in Amia. Wilder, B. G. 1877.5, 1886.1; Wright, R. R. 1885.1.

Breathing valves. *Structure and function of maxillary and mandibular breathing valves in Teleostomi. — Polypterus.* Allis, E. P. 1900.2. *— Teleosts.* Dahlgren, U. 1898.2; ★Mitchell, E. G. **1904.1.** *— Pleuronectidæ.* Schmidt, P. F. 1915.1.

Innervation of breathing valves. Fusari, R. 1907.2.

Spiracle *or the persistent vestigial hyomandibular or first gill cleft. Morphology. — Dipnoi.* Agar, W. E. 1906.2. *— Acipenser.* Virchow, H. 1890.3. *— Remnants in Amia and Lepidosteus.* Wilder, B. G. 1878.2; Wright, R. R. 1885.4. *— Anatomy and development in Ganoidei.* Dohrn, A. Add. 1886.1.

Anatomy and development in Elasmobranchii. Cleland, J. 1886.2; Ewart, J. C. (*Lamna*) 1890.3; Moroff, T. 1904.1; Ridewood, W. G. 1896.1; Turner, W. 1875.2; Virchow, H. 1890.2.

Functions of the spiracles. Budgett (J. S. 1903.1), in his work with Polypterus, observed the escape of air from the spiracles after the fish had gulped air at the surface. He believed that "the spiracles in this form are used to take in and to give out air from the swim-bladder."

Rand (H. W. 1907.1) observed the spouting of water from the spiracle in the skate (Raja) and concluded that in addition to this causing a respiratory incurrent through the mouth, the fish regularly employs spouting or the spiracular excurrent "as a means of keeping the eyes unobstructed."

Similar observations of Darbishire (A. D. 1907.1) with Raja indicate that this form expels water as "a means of ridding the pharynx of unpleasant matter."

Fulton (T. W. 1904.1, vi) has observed the reversed action of the gill-covers in plaice which were clinging to the tank with their snouts out of water. In this case the water was drawn in from behind through the gill-openings and spouted "as a little fountain, an inch or so in height."

VASCULAR RESPIRATORY ORGANS

True organs of respiration, of which gills form the usual type, found in all fishes.

Vascular filaments of pelvic fin of male Lepidosiren, presumed to function as adjunct respiratory organs during breeding season. Agar, W. E. 1908.1; Kerr, J. G. 1900.1; Lankester, E. R. 1894.1.

ACCESSORY BRANCHIAL ORGANS

For a comprehensive paper covering all types of accessory branchial organs, with a review of the literature, see ★Rauther, M. **1910.1.**

Accessory organs (all types) in Indian fishes. ★Day, F. 1877.3; Hyrtl, C. J. 1858.3; Müller, J. 1840.4; Taylor, J. 1831.2, 1835.1.

Accessory branchial cavity. *Simple cavity lined by vascular membrane, of Ophiocephalidæ.* Grigorian, C. 1900.1; Hyrtl, C. J. 1853.1.

Arborescent appendages. —*Heterobranchus*, Alessandrini, A. 1842.1. —*Clarias*. Böhme, R. 1904.2; Sørensen, W. E. 1883.1; Vaillant, L. L. 1895.3, 1896.3.

Extensive air-sacs of Saccobranchus. Burne, R. H. 1894.1; Hyrtl, C. J. 1854.4; Wyllie, J. 1840.1.

Paired lung-like outgrowth of branchial cavity (cæcal diverticula); small sacs in Amphipnous. Hyrtl, C. J. 1858.3; Taylor, J. 1831.2.

Gill-helix type of appendages. —*Hypophthalmichthys*. Boulenger, G. A. 1901.20. —*Heterotis, and Clupeidæ*. ★Hyrtl, C. J. 1854.1, 1855.1, 1862.1, 1863.2. —*Characinidæ*. Kner, R. 1861.2. —*Citharinus*. Sagemehl, M. 1886.1.

Arborescent appendages of Pœciliidæ, chiefly Lebias. Mazza, F. 1907.1.

Labyrinthiform organs. *Structure, etc.* —*Labyrinthici*. Böttger, W. C. 1912.1; ★Henninger, G. **1908.1**; Peters, W. C. H. 1853.1; Zograf, N. Y. 1886.1, 1888.1; Meyer, P. E. Add. 1904.1. —*Polyacanthus*. Hyrtl, C. J. 1863.4. —*Betta*. Schachmagonow, T. 1900.1.

EXTERNAL GILLS

Transitory in nature

For a comprehensive general treatise on external gills, see ★Clemens, P. **1895.1.**

False External Gills

In the young of many Selachians and certain Teleosts, the gill lamellæ are prolonged as filaments which project to the exterior. In literature, these are generally called "external gills," although they should not be confused with the following type.

Structure and development in fœtal Elasmobranchii. Blainville, H. M. 1818.3; Cornalia, E. 1856.1; ★Leuckart, F. S. 1836.1; Schenk, S. L. 1875.1.

For external gills of viviparous shark embryos acting as placentæ, see Nourishment of embryo *under* Viviparity *under* Reproduction.

Structure in the Teleosts, Gymnarchus and Heterotis. Assheton, R. 1907.2; Budgett, J. S. 1900.5, 1901.1. —*Structure in Misgurnus (Cobitis)*. Goette, A. 1878.3.

True External Gills

True external gills of the same morphological nature as those of Urodele amphibians, occur in Crossopterygii (Polypterus) and in the Dipnoans, Protopterus and Lepidosiren.

Structure of external gills in Protopterus. Budgett, J. S. 1900.5, 1901.1. —*In Lepidosiren*. Kerr, J. G. 1900.1.

Alleged but non-existent in Neoceratodus. Semon, R. 1894.1.

Structure of external gills of Polypterus. Boulenger, G. A. 1899.8; Budgett, J. S. 1900.4, 1901.1, 1902.2; Hyrtl, C. J. 1869.1; Steindachner, F. 1869.2; Anon. 200.

For the External gill hypothesis *in the* Phylogenesis of limbs, *see under* Evolution.

GILLS

For related structures *see* Branchial arches *under* Visceral skeleton.

For Gill-muscles, *see under* Myology.

For the latest and most authoritative works on the apparatus of respiration, see ★Oppel, A. Add. **1905.1**, 1906.1.

Anatomy and morphology. *General researches*. Goette, A. 1901.1; Greil, A. (*Homologies*) 1906.2; Huschke, E. 1818.1; Popta, C. M. L. 1901.2,.3; Riess, J. A. 1881.1; Lereboullet, D. A. Add. 1838.1; Williams, T. Add. 1859.1.

Shorter papers on the morphology of the gills. Howes, G. B. 1891.3; Lo Giudice, P. 1910.1; Rosenthal, F. 1839.1; Treviranus, G. R. 1830.1; Baer, K. E. Add. 1827.1.

Structure of gills in various fishes. —*Orthagoriscus*. Alessandrini, A. 1839.1. —*Petromyzon*. Giacomini, E. 1900.1. —*Petromyzon and Myxine*. Home, E. 1815.3. —*Silurus*. Geoffroy-Saint-Hilaire, E. F. 1802.6. —*Amphioxus*. Spengel, J. W. Add. 1891.1. —*Syngnathus*. Tiedemann, D. F. 1816.1.

Development of gills. —*Teleosts*. ★Goette, A. 1878.3, 1901.1; Moroff, T. 1902.2, 1904.1. —*Ceratodus*. Greil, A. 1906.1; Kellicott, W. E. 1905.1. —*Bdellostoma*. Stockard, C. R. 1906.2, 1908.1.

Histology. Faussek, V. A. 1902.1; Montgomery-Vignal, M. W. 1874.1; Plehn, M. 1901.1. —*Elasmobranchii*. Alessandrini, A. 1840.1; Dröscher, W. 1881.1; Todaro, F. 1873.1, Add. 1873.1. —*Xiphias*. Trois, E. F. 1883.1.

PSEUDOBRANCHIÆ

Accessory or rudimentary gills which in Ganoidei and Teleostei play some part in respiration.

Development, morphology and function. —*Teleostei*. Gemmill, J. F. 1899.1; Maurer, F. 1884.1, 1888.1; Müller, J. 1839.2, 1840.2,.4, 1841.1,.3; ★Grassi, G. B. Add. 1914.2. —*Morphology and development, Lepidosteus*. ★Müller, F. W. 1897.1. —*Morphology, Ganoidei*. Wright, R. R. 1885.2,.4. —*Ganoidei and Teleostei*. Dohrn, A. Add. 1886.1.

RIBS OF FISHES

As first shown by Goette (A. 1878.1,) two morphologically independent structures have been known under the name of "ribs," in addition to the intermuscular or small bones found in the myosepta of Teleosts.

The dorsal ribs lie at the level of the horizontal septum dividing the lateral musculature. They occur in Elasmobranchs and are considered as homologous with the ribs of Amniotes.

The ventral ribs lie immediately outside the splanchnocoelic lining and are apparently serially homologous with the hæmal arches of the caudal vertebræ. In general in Teleostomes and Dipnoi, only this type of rib is found.

Both sets of ribs occur in the Crossopterygii.

For an excellent account of the development of the ribs in fishes, see ★Schauinsland, H. Add. **1905.1.**

Ribs — *Cont'd.*

Anatomy and morphology of the fish ribs. ★Baur, G. H. 1887.3, 1889.1, 1893.1; Cleland, J. 1863.1; ★Dollo, L. 1892.2; Eschricht, D. F. 1850.1, 1851.1; ★Goeppert, E. 1895.1, 1897.1; Hatschek, B. 1889.2; Lavocat, A. 1889.1; Mayerhofer, F. 1908.1; Müller, A. 1853.1; Wilbrand, J. B. 1824.1, 1838.1; Claus, C. Add. 1877.1.

Demonstration of presence (previously denied) in Polyodon of cartilaginous ribs. Bridge, T. W. 1897.2,.3.

Presence anteriorly of both types of ribs in Polyacanthus. Hyrtl, C. J. 1863.4.

Description of a pair of freely articulated occipital "ribs" in Micropterus. Shufeldt, R. W. 1884.1,.2. — *Suggestion that these are rudiments of the supraclaviculæ.* McMurrich, J. P. Add. 1884.1.

SENSES AND SENSE ORGANS (*OF FISHES*)

For the morphology of the various organs of sense, *see under* Auditory organs, Gustatory organs, Eye, Olfactory organs, *and* Tactile organs.

For the functions of these organs, *see* Hearing, Smell, Taste, *and* Vision.

For local and specialized sense organs, *see under* Lateral line system, *and* Nervous system.

For all psychological reactions in fishes, involving sensory perceptions, *see under* Behavior.

Morphological and physiological classification of sense organs. Herrick, C. J. 1903.1.

General treatises on sense organs. Chatin, J. 1880.1; Lenhossék, M. 1894.1, 1895.1; ★Lubosch, W. **1910.1**.

Branchial sensory organs (ectodermal thickenings above each gill cleft, from which arise lateral line and mucus canal sense organs) and their phylogenetic significance. Beard, J. 1885.2; Beraneck, E. 1889.1; Peter, K. 1901.1; Wilson, H. V. 1897.1.

General treatises on the senses of fishes. ★Baglioni, S. Add. 1912.1; ★Nagel, W. A. Add. 1894.1.

Electric and magnetic dermal senses. Dunn, M. Add. 1899.1.

End organs or the nerve-end apparatus. *Called also epidermal sense organs (Hautsinnesorgane) or terminal buds. (It is impossible at present to state with certainty the functions of these nerve end organs and to assign them to the different senses).*

General treatises. ★Leydig, F. **1895.1**; ★Merkel, F. 1880.1.

Anatomy and morphology. Afanassjew, M. J. 1874.1; Herrick, C. J. 1903.2; Hofer, B. 1908.1; Leydig, F. 1879.1, 1888.1; Ritter, W. E. 1893.1; Schulze, F. E. 1863.1; Trojan, E. 1904.1, 1905.1; Lenhossék, M. Add. 1894.1.

End organs of trigeminus and lateralis nerves, Bdellostoma. Ayers, H. & Worthington, J. 1907.1.

Skin sensory organs, relation to mammalian hair. Leydig, F. 1893.1; Maurer, F. 1893.1, 1895.1.

Skin sensory organs of Fierasfer. Nusbaum, J. & Bykowski, L. 1905.1. — *Spinax.* Rund, G. Add. 1914.1.

Presence of terminal organs resembling touch corpuscles in intra-muscular connective tissue. Purvis, G. C. 1890.1.

For nerve terminations in particular organs, see "Innervation" under such organs as Heart, Integument, etc.

SEX-RATIO (*IN FISHES*)

The relative proportions of the sexes in fishes.

General papers. Fulton, T. W. 1890.4; Pittet, L. Add. 1914.1.

The sex-ratio in — Gasterosteus. Braun, M. G. 1904.1. — *Salmon in Scottish rivers.* Calderwood, W. L. 1904.1. — *Sharks and rays.* Fulton, T. W. 1903.2; Haacke, W. Add. 1885.1. — *Plaice.* Hefford, A. E. 1909.1. — *Syngnathidæ.* Marcusen, J. 1873.1. — *Spinax.* Punnet, R. C. 1904.1.

Sex-ratio in broods of aquarium fishes, chiefly viviparous Pœciliidæ, alleged to vary from nearly all males to nearly all females according to age of parent fishes. Thumm, J. 1908.1 (pp. 519–521).

For an illuminating suggested explanation of similar fluctuations in the sex-ratio of Lebistes reticulatus, see ★J. S. Huxley, *in* Journal of Genetics, 1920, vol. 10, pp. 265–276. *Huxley suggests that instead of sex-determination by chromosomes being fixed and unmodifiable, there is a possibility of external factors overriding their effects, and that thus some males are "masculinized females," i. e. males with XX or female genetic constitution. Such individuals will always give a preponderance of the sex opposite to their own.*

For the sex-ratio of Lebistes in a wild state considered the normal 1 : 1 ratio, see Henn, A. W. 1916.1 (p. 106).

Case of sex reversal or "arrhenoidie" in a viviparous Pœciliid; in a female, the anal fin elongated to twice its normal length, resembling the characteristic appearance of half-grown males. Philippi, E. 1904.1.

For additional discussion of the sex-ratio of the Pœciliidæ, see R. L. Barney & B. J. Anson, *in* Ecology, 1921, vol. 2, pp. 53–69.

SEXUAL DIMORPHISM

General treatises on the sexual dimorphism of animals, including fishes. ★Cunningham, J. T. 1900.2; ★Darwin, C. R. 1883.1.

Miscellaneous papers. Holt, E. W. 1898.1; Surbeck, G. 1913.1, 1914.2; Landeck, A. Add. 1914.1.

Sexual dimorphism shown in dentition of — Raja. Lütken, C. F. 1874.3,.5. — *Notidanus.* Macdonald, J. D. & Barron, C. 1868.1. — *Mobula.* Pellegrin, J. 1912.12.

Sexual dimorphism shown in rostral spine of males of Myriacanthus, Squaloraja, and Chimæra. Davies, W. 1872.1; Dean, B. 1906.1; Reis, O. M. 1895.2; Woodward, A. S. 1906.3.

Sexual dimorphism in — Anal fin, Mallotus. Agassiz, J. L. 1860.1. — *Pectoral fin, Cobitis tænia.* Canestrini, G. 1871.3,.4; Troschel, F. H. 1871.1. — *Pectoral fins, Cyprinidæ.* Fatio, V. 1875.1. — *In size.* Fulton, T. W. 1890.4. — *In skeleton.* Günther, A. C. 1859.3.

For sexual dimorphism in pelvic fins of sharks, see Copulatory organs *under* Viviparity *in section on* Reproduction.

For the differentiation of the male anal fin of Pœciliidæ as an intromittent organ, see under Ovarian gestation *under* Viviparity *as above.*

Frontal gibbosity, a swelling or protuberance on the head of certain male fishes, which may be considered a secondary sexual character. It becomes gradually more prominent as sexual maturity is reached, and is very greatly enlarged during the breeding season. — General account of anatomy and physiological significance. Pellegrin, J. 1904.2. — *Geophagus and Cichla.* Agassiz, L. & Agassiz, E. C. 1868.1; Steindachner, F. 1874.3, 1877.1 (i). — *Julis and Scarus.* Cuvier, G. & Valenciennes, A. 1828.1 (vol. 14). — *Semicossyphus.* Günther, A. C. 1859.1. — *Pimelometopon.* Jordan, D. S. & Evermann, B. W. 1896.2. — *Percidæ.* Pellegrin, J. 1901.2. — *Ptychochromis.* Pellegrin, J. 1907.14.

Sexual dimorphism in various Teleosts

Sub-order Acanthopterygii. — *Callyodon.* Bloch, M. E. 1788.3. — *Arnoglossus.* Cunningham, J. T. 1890.1. — *Rhomboidichthys.* Facciolà, L. 1886.1. — *Smaris.* Facciolà, L. 1899.1. —*Lepadogaster.* Guitel, F. 1890.4. — *Hemichromis.* Kutzner, A. 1909.1. — *Cichlasoma.* Reuter, F. 1914.1. — *Coris.* Trois, E. F. 1905.1. —*Lucioperca.* Vutskits, G. 1915.1, 1916.1. — *Mesogonistius.* Anon. 263. — *Pterophyllum.* Conn, C. Add. 1914.2.

Sub-order Ostariophysi. — *Tinca.* Andres, A. 1897.1; Canestrini, G. 1872.1. — *Rasbora.* Arnold, J. P. 1911.25. — *Callichthys.* Kner, R. 1854.3. — *Corydoras.* Steindachner, F. 1910.2. — *Neosilurus.* Troschel, F. H. 1870.1. —*Leucaspius.* Vutskits, G. 1903.1.

Fishes of various other sub-orders. — *Coregonus.* Carpenter, C. 1878.1. — *Stigmatophora.* McCulloch, A. R. 1914.3. — *Syngnathidæ.* Marcusen, J. 1873.1. — *Cynolebias.* Regan, C. T. 1912.22.

For sexual dimorphism in eels, see Sexes of Eels, *under* Anguilla *in the Systematic part of the Subject Catalogue.*

SKELETON OF FISHES

Comprising the morphology of the inner cartilaginous or bony endoskeleton, and the general subject of Osteology.

The "exoskeleton," consisting of the dermal denticles and scales, is treated *under* the caption "Dermal skeleton."

The wide usage, among authors, of the term "exoskeleton" for the dermal skeleton has necessitated the retention of this term in the present work. Long ago, Ryder (J. A. 1885.2, p. 204) pointed out that "the distinction between the fin-rays as exoskeletal, from the other bones as endoskeletal, . . . breaks down on embryological grounds, for both are clearly of mesoblastic origin." More recently, Prof. J. G. Kerr (Text-book of Embryology, vol. 2, p. 289) considers the use of the term "exoskeleton" for fish-scales as unfortunate, and limits this term to the true chitinous exoskeleton of various invertebrates.

The present section is largely limited to general papers on the fish-skeleton. The full literature will be found by reference also to the papers *cited under* Pectoral girdle; Pelvic girdle; Ribs; Skull; Vertebral column; *and* Visceral skeleton.

The abnormalities of the skeleton are listed *under* Teratology.

For the preparation of skeletons for research and class room work, *see* Technical methods, etc.

The many described forms of fossil fishes are known solely from their skeletal remains. The extensive literature can, of course, not be included here. Reference should be made elsewhere in this work and also especially to the "catalogue" of Woodward (A. S. 1889.2).

General treatises

No satisfactory general treatise on the skeleton of fishes, of recent date, exists. The following references comprise the existing general treatises.

Text in English. Owen, R. 1848.1, 1866.3; ★Reynolds, S. H. 1913.1.

Text in French. Lidth de Jeude, T. W. 1898.1; ★Pouchet, G. & Beauregard, H. 1889.1; ★Stéphan, P. **1900.1**; Owen, R. Add. 1855.1.

Text in German. Brühl, C. B. 1856.1, 1887.1, Add. 1845.1, 1847.1.

An early general treatise, in English, is Cheselden, W. Pre-Linn. 1733.1.

For the synonymy of the numerous terms which have been applied to the bones of the fish-skeleton, see ★Starks, E. C. 1901.1.

Miscellaneous papers

The following citations represent older, unimportant, and miscellaneous papers on the skeleton of fishes. Ekama, C. 1822.1; Geoffroy-Saint-Hilaire, E. 1817.2, 1824.2; Hoeven, J. 1822.1; Hollard, H. L. 1861.1; Macdonald, W. 1838.1, 1872.1; Mivart, St. G. 1871.1; Owen, R. 1846.2; Rosenthal, F. 1811.1; Segond, L. A. 1873.1; Sgarzi, G. 1849.1; Shufeldt, R. W. 1916.1.

Tissues characterized by the presence of a high proportion of intercellular substance, or matrix, which is a product of the surrounding cells themselves, occur widely distributed throughout the animal body. When the intercellular substance is sufficiently dense, or is strengthened by the deposition of lime salts, these tissues may provide support for the other body tissues.

SKELETOGENOUS TISSUES

The skeletogenous or connective tissues, including cartilage and bone, all arise from the mesenchyme.

The Connective Tissues

Comprising areolar, reticular, fibrous, and elastic tissues, which have not been separated in the following references.

Skeleton — *Cont'd.*

The most comprehensive general treatise on the origin and development of connective tissue (in German), with an extensive bibliography, is ★Merkel, F. **1909.1**.

Various papers on the development, histology, histogenesis, etc., of connective tissue are Ebner, V. 1896.1; Ferguson, J. S. 1912.1; Goldschmidt, R. 1908.1; ★Key, A. & Retzius, G. 1875.1; Müller, E. 1912.1; Policard, A. 1902.1; Studnička, F. K. 1897.6, 1902.1, 1906.2, 1907.1; ★Szily, A. 1908.1.

The umbilical cord of mammals is composed of a mesenchymal tissue known as "mucous tissue." For the structure of an analogous connective tissue in the "umbilical cord" (yolk-sac) of Torpedo, see Laguesse, G. E. 1911.1, 1913.1.

For the references to "Fat, or adipose tissue," which is formed from areolar connective tissue, see under Chemistry.

Cartilage

Cartilage, a dense tissue possessing flexibility and elasticity, forms the skeletal tissue of Cyclostomes and Elasmobranchs and is in these forms never replaced by bone.

In the embryo or larval bony fish (Teleost), and in all higher vertebrates, the skeleton is originally formed of hyaline cartilage, which is later replaced by bone.

In adult Selachians, cartilaginous structures, such as the vertebræ, usually become "calcified" or hardened by the deposition of calcium carbonate in the form of polygonal plates between the peripheral cartilage cells, as is best shown by Lubosch (W. 1909.1) and by Roth (W. 1911.1, p. 496). Despite the statements of Stark (James 1844.2), true bone is not developed in these fishes.

The origin of cartilage is difficult to follow. As quoted from an abstract in the Journ. Roy. Micro. Soc., 1898, 2nd. series, vol. 17, p. 290, "Prof. F. K. Studnička, [1898.4] shows that the origin of cartilage does not imply occurrence of *special* cells. In the post-embryonic life of Cyclostomes, cartilage may arise from (1) the dense connective-tissue of perichondrium and fascia; (2) the loose connective-tissue; (3) the so-called *Schleimknorpel;* (4) the *Vorknorpel* (*vesicular* supporting tissue of Schäffer); (5) the axial connective-tissue of the caudal fin; (6) highly specialized tissue, such as fatty tissue; and (7) the epithelium of the notochord."

The most extensive recent summary of this subject, with a full bibliography, is ★Studnička, F. K. **1903.2**.

Excellent treatises, containing complete bibliographies, on the development of hyaline cartilage in all groups, are ★Novikov, M. M. **1908.1**; *and for the chemical composition especially,* ★F. C. C. Hansen *in* Anat. Hefte, 1905, Bd. 27, Hft. 83, pp. 535–820, 10 pls.

The structure of cartilage in the Cyclostomes is most completely treated by ★Schaffer, J. 1896.1–**1901.2**, 1910.1; *and by* ★Studnička, F. K. 1897.4,.6, 1898.1,.4.

The histological structure in Elasmobranchs is treated by Hasse, J. C. 1879.2, *and by* ★Roth, W. **1911.1**.

Other papers on the development or structure of cartilage are Nardo, G. D. 1843.1, 1845.1; Retterer, E. 1907.1; Srdinko, O. V. 1902.1; Valenciennes, A. 1851.3; *and* Kaschkaroff, D. N. Add. 1914.2.

The development of cartilage and cartilage cells has been especially studied in connection with the development of the notochord and the vertebral column. For references, see under Vertebral column.

For the chemical composition of cartilage, see under Chemistry.

Bone

True bone is characterized by the presence of *included* bone-cells (called also bone-corpuscles, calcigerous cells, and osteoblasts), which generally occupy the lacunæ of the Haversian system and thus are included in or surrounded by the lamellated bone matrix. It is first met with in the "bony fishes" (Teleostomes).

Dentine, closely allied to bone, is more dense and its formative cells (scleroblasts or odontoblasts) are *not included* in the matrix. The scleroblasts, which secrete the dentine, line the proximal side of the developing denticle or tooth so that growth, in contrast with bone, is in only one direction, *i. e.* outward. Dentine occurs in the dermal denticles of Elasmobranchs (*see* Dermal skeleton) and in the teeth of these fishes and all higher vertebrates (*see* Dentition).

Modern views on the histology of the bone of fishes begin with the work of H. Müller (Zeitschr. wiss. Zool., Bd. ix, 1858) who first correctly distinguished ossification (from calcification) as the osteoblastic elaboration of cartilage. Williamson (W. C. 1851.1) previously had considered bone to be formed by the calcification of cartilage.

Many genera of Teleosts possess no "bone corpuscles" (*i. e.* lacunæ occupied by osteoblasts) and their bones therefore in minute structure much resemble dentine. This subject has been elaborated by Kölliker (R. A. 1859.1,.2) who microscopically examined more than two hundred species of fishes. He found that "most of the higher organized fishes are amongst those with bone-corpuscles," including roughly the Physostomi; Malacopterygii and Ostariophysi (except Thricomycterus), and the Ganoids. Those without "bone-corpuscles" roughly include the Anacanthini and Pharyngognathi, the Symbranchii, Haplomi, Plectognathi, and all of the "Acanthopteri, with the exception of the genus Thynnus," etc. For the tissue lacking bone corpuscles, Kölliker (R. A. 1859.2, p. 258) used the term "osteoides Gewebe." This work has served as the basis for most modern histological researches on the bones of fishes.

The lack of bone-cells was originally noted by ★Queckett (J. T. 1849.1); *by* Williamson (W. C. 1851.1, p. 693); *by* Kölliker (R. A. 1853.1, p. 361); *and by* Mettenheimer (C. F. 1854.1).

Pouchet observed that, in the same individual, some bones may possess bone-cells while others lack them. Pouchet, G. 1875.2.

Other papers also containing accounts of the bone-cells. Goette, A. 1878.1 (v); Grassi, G. B. 1885.1; *and* ★Stéphan, P. 1898.2.

The most valuable paper on the histology of the bones of fishes (in French), containing a historical and a full bibliographic résumé, is ★Stéphan, P. **1900.1**.

Papers treating of various phases of the histology or histogenesis of the bones of fishes. Aladyna, M. 1910.1,.2; ★Gegenbaur, C. 1864.1, 1867.2; Goodrich, E. S. 1913.2; Köstler, M. 1882.1; Renaut,

J. 1902.1; Retterer, E. 1905.1–.3; ★Schmid-Monnard, C. 1893.1; Stieda, L. 1872.1; Studnička, F. K. 1906.2; Williamson, W. C. 1851.1; Kaschkaroff, D. N. Add. 1914.3.

True bone occurs in the Coccosteomorphi (*Arthrodira*). Gebhardt, W. 1907.1.

The histological structure of bone, in the ocean sun-fish, Orthagoriscus, has been much studied. The most recent paper (*Kaschkaroff*) *considers them without bone cells. This paper also reviews all preceding papers.* Beauregard, H. 1893.1; Cleland, J. 1862.1; Harting, P. 1865.3; Kölliker, R. A. 1860.8; Novikov, M. M. 1909.1, 1910.1; Supino, F. 1904.1; ★Kaschkaroff, D. N. Add. 1914.3.

The osteoblasts, previously generally considered mesodermal in origin, were described by Klaatsch (H. 1894.1) *as arising in the ectoderm and thence migrating into the mesoderm. This possibility was reviewed by* Kingsley (J. S. 1894.1). Harrison (R. G. 1895.1) *re-investigated the matter and reaffirmed their mesodermal origin. These older views are likewise maintained in a more complete review by* ★Rosén (N. 1910.1).

SKELETON BY GROUPS

The skeletons of the following forms are more completely treated elsewhere herein under the constituent parts, such as Pectoral girdle; Pelvic girdle; Skull; Vertebral column; and Visceral skeleton. The following references therefore chiefly constitute accessory, general, inclusive, or unclassifiable papers.

CYCLOSTOMATA

Ayers, H. & Jackson, C. M. 1900.1; Cole, F. J. 1905.1; Gegenbaur, C. 1870.3; ★Parker, W. K. **1884.1;** Schaffer, J. 1901.2; Perepelkin, K. Add. 1882.1.

DIPNOI

★Fürbringer, K. 1904.1; Wiedersheim, R. E. 1880.2.

ELASMOBRANCHII

Baudelot, E. 1869.3; Goodey, T. (*Chlamydoselachus*) 1910.1; ★Haswell, W. A. 1885.2; Jaquet, M. (*Pseudotriacis*) 1905.1; Molin, R. 1853.2, 1859.1; Regan, C. T. 1906.1; Treviranus, G. R. 1804.1.

Excellent figures. Garman, S. 1913.1.

CHIMÆRIDÆ

Skeletons figured and described. Garman, S. 1904.1.

OSTEOLOGY OF TELEOSTOMI

Chondrostei and Holostei. Anatomy of the skeleton of — *Polyodon.* ★Bridge, T. W. 1878.1. — "*Knochenganoiden.*" Cafauek, F. 1883.1. — *Acipenser.* Molin, R. 1851.2; Zalenskiĭ, V. V. 1878.1. — *Amia.* ★Shufeldt, R. W. 1885.1.

Teleostei

It should be stated here that most of the following references include the structure of the skull. Other parts of the skeleton, such as the vertebral column, pectoral girdle, ribs, etc., receive treatment but less generally than the skull, which is almost always included.

Sub-order Malacopterygii

Structure of the skeleton of — *Coregonus.* Bayer, F. 1889.1. — *Salmo salar.* Bruch, C. W. 1861.3, 1862.1; Morrow, R. 1880.1. — *Gymnarchus.* Erdl, M. P. 1847.1. — *Alosa sapidissima.* Hitchcock, F. R. 1887.2, 1888.1. — *Clupeidæ.* Hyrtl, C. J. 1861.2. — *Mormyridæ.* ★Marcusen, J. 1864.1. — *Cromeria and Galaxias.* Swinnerton, H. H. 1903.1.

Sub-order Ostariophysi

Skeleton of Characinidæ. — *Gastropelecus.* Ridewood, W. G. 1913.1; Young, G. W. 1915.1.

Skeleton of Cyprinidæ. — *Tinca.* Andres, A. 1897.1, 1899.1. — *Cyprinus carpio.* Bruch, C. W. 1861.2; Brühl, C. B. 1891.4; Maslowsky, A. 1855.1.

Skeleton of Siluridæ. — *Malopterurus.* Cleland, J. 1858.1. — *Siluridæ.* Hyrtl, C. J. 1859.1; ★Koschkarov, D. N. 1905.1. — *Amiurus.* McMurrich, J. P. 1884.2.

Sub-order Apodes

Osteology of the fishes of the sub-order Apodes. Regan, C. T. 1912.15.

For the osteological characters of the following families of the sub-order Apodes, see the present citations under Gill, T. N. *as follows.* — *Anguillidæ.* 1891.8. — *Murænesocidæ.* 1891.10. — *Murænidæ.* 1891.11. — *Simenchelyidæ.* 1891.12. — *Synaphobranchidæ.* 1891.13.

Sub-order Haplomi

For the most recent delimitation of this group, see Regan, C. T. 1911.15.

Osteology of Dallia pectoralis. Starks, E. C. 1904.1. — *Esocidæ.* Starks. 1904.3.

Sub-order Catosteomi

Osteology of — *Lampris guttatus.* Bakker, G. 1822.1; Ekhoff, E. 1875.1. — *Lophobranchii.* Jungersen, H. F. 1909.1. — *Syngnathus.* McMurrich, J. P. 1883.1.

Osteology of the Hemibranchii, including the following families or genera: Æoliscus, Aulichthys, Aulorhynchidæ, Aulostomidæ, Centriscidæ, Fistulariidæ, Gasterosteidæ, and Macrorhamphosidæ. Starks, E. C. 1902.2.

Sub-order Percesoces

Osteological characters of the fishes of the following families or genera: Atherinopsis, Menidia, Mugilidæ, and Sphyrænidæ. Starks, E. C. 1899.1.

Osteology of Ophiocephalus. Day, A. L. Add. 1914.1.

Sub-order Anacanthini

Osteology of the Gadidæ. Bakker, G. 1822.1; Brooks, H. St. J. 1885.1; Newton, E. T. 1895.1, Add. 1875.1; Williamson, H. C. 1902.1.

Skeleton — *Cont'd.*

Sub-order Acanthopterygii

Structure of the skeleton of — Cataphracti. Berg, L. S. 1906.12. — *Pleuronectes.* ★Cole, F. J. & Johnstone, J. 1901.1. — *Lutjaninæ.* Gill, T. N. 1885.4. — *Etheostominæ.* Jordan, D. S. & Eigenmann, C. H. 1886.1. — *Lopholatilus.* Lucas, F. A. 1905.1. — *Thynnus.* Masterman, A. T. 1894.1. — *Regalecus.* ★Parker, T. J. 1886.3. — *Micropterus.* Shufeldt, R. W. 1884.1,.2, 1901.10. — *Kurtus.* Beaufort, L. F. Add. 1914.1.

Skeleton of Luvarus imperialis (Ausonia and Proctostegus are synonyms). Günther, A. C. 1866.7; Nardo, G. D. 1827.1, 1840.1; Regan, C. T. 1903.9; Waite, E. R. 1902.3.

Osteology of the Scombridæ and Carangidæ. Regan, C. T. 1909.13; Starks, E. C. 1909.1, 1910.1, 1911.4,.5; Vaillant, L. L. 1885.2.

Osteology of some berycoid fishes (Berycoidea), including the following families or genera: Holocentridæ, Hoplostethus, Monocentridæ, Myripristis, Polymixidæ, and Trachichthyidæ. Starks, E. C. 1904.2.

For additional papers on this group, see below under " Researches of Starks."

Sub-order Pediculati

Skeletal anatomy of — Ceratias. Lütken, C. F. 1880.1,.4. — *Lophius.* Morrow, R. Add. 1882.1.

Sub-order Plectognathi

Skeleton of — Balistes. Brühl, C. B. 1891.2; Hollard, H. L. 1853.1; Klein, E. E. 1872.1. — *Triodon.* Dareste, C. 1849.1. — *Gymnodontidæ.* Hollard, H. L. 1857.1, 1860.1. — *Diodon.* Shufeldt, R. W. 1917.2.

Special researches on the osteology of Teleosts

Since the taxonomic groupings, such as orders and sub-orders, are largely based on skeletal or skull characters, an extensive literature has been developed. It is of course obviously impossible to note here all of the many taxonomic works containing summaries of such distinctive characters. The following references primarily define the osteological basis for these groupings. The chief workers in this field are Gill, Regan, and Starks.

Reference may advantageously be made to " The orders of teleostomous fishes." ★Gregory, W. K. 1907.1.

Researches of Gill

The chief references to this author are ★Gill, T. N. 1885.4, 1891.7–.13. *See also those cited under* " *Apodes.*" *See also, for — Amphipnoidæ.* 1891.7, *and — Hemitripteridæ.* 1891.9.

Researches of Regan

Papers of the highest type, defining the osteological characters of the following groups (considered " orders " unless otherwise stated), are cited under ★Regan, C. T. *as follows. — Sub-order Allotriognathi, including the families Lamprididæ, Veliferidæ, Trachypteridæ, and Lophotidæ.* 1907.11.

Scombriformes, including Carangidæ and Scombridæ. 1909.13. — *Iniomi.* 1911.2. *Salmopercæ.* 1911.3. — *Berycomorphi, and Xenoberyces.* 1911.4. — *Gobioidea,* 1911.14. — *Microcyprini.* 1911.15. — *Apodes.* 1912.15. — *Opisthomi.* 1912.16. — *Scleroparei.* 1913.13.

Researches of Starks

Works likewise of the very highest order, and having the advantage of excellent illustrations, are those cited under ★Starks, E. C. 1898.1–1911.5. *In detail, they are listed partly above under Catosteomi, Percesoces, and Acanthopterygii, and partly under the following families or genera of Acanthopterygii. — Sebastolobus.* 1898.1. — *Zeidæ.* 1898.2. — *Dinolestes.* 1899.2. — *Antigoniidæ.* 1902.1. — *Caularchus.* 1905.1. — *Stylephorus.* 1908.1. — *Gempylidæ, Lepidopidæ, and Trichiuridæ.* 1911.3. — *Leiognathus.* 1911.4.

SKULL OF FISHES

The full literature on the skull will be found by consulting also the *sections on* Skeleton *and* Visceral Skeleton.

For the " Abnormalities of the skull," *see under* Teratology.

" The skull is a complex structure and the last word concerning its composition has yet to be said." (Kingsley.)

Probably the most valuable general treatise on the development and morphology of the vertebrate skull (text in German), with a full bibliography, is ★Gaupp, E. Add. **1905.1.**

Unquestionably the most learned treatises in English, illustrating the anatomy of the fish skull (bones, nerves, foramina, etc.) in remarkable detail, are those cited under ★Allis, E. P. 1897.1, 1898.3, 1899.2, 1900.2, **1903.4**, 1904.1, 1907.1, **1909.1**, 1913.1, etc.

Other valuable treatises on the morphology of the fish skull, in English, are those of ★Parker, W. K. 1872.1, 1879.2, 1881.1, *and* 1882.1.

Various papers of a general or unclassified nature including the morphology of the fish skull. Baur, G. H. 1889.2; Geoffroy-St.-H., E. F. 1807.1, 1824.1, 1825.2; Goodsir, J. 1857.2; ★Gregory, W. K. 1913.1; ★Klein, E. E. 1868.2; ★Köstlin, O. 1844.1; Mead, C. S. 1904.1; Owen, R. 1848.1; ★Parker, W. K. & Bettany, G. T. 1877.1; Spitznagel, F. 1821.1; Sutton, J. B. 1887.1; Voskoboinikov, M. M. 1914.1; Wright, William. 1909.1.

PHYLOGENY OF THE SKULL

Vertebral theory of the skull

Many of the statements in the present summary are based on the above account of Gaupp (E. Add. 1905.1).

" A young skull " (says Huxley, T. H. Add. 1859.2, p. 383) " may be readily separated into a number of segments, in each of which it requires but little imagination to trace a sort of family likeness to such an expanded vertebra as the atlas.

> "What can be more natural then than . . . to conceive the skull as a portion of the vertebral column still more altered than the sacrum or the coccyx, whose vertebræ are modified in correspondence with the expansion of the anterior end of the nervous centre."

Precisely this conception arose in the mind of the "fanciful philosopher" Oken after observing the bleached skull of a deer which he picked up one day in 1806 in the Harz forest.

These views, published in 1806 but chiefly expressed in lectures, met with general acceptance (Bojanus, L. 1818.1, .2). In 1820, the poet Goethe in his "Morphologie" stated that, thirty years previously, he had discovered this relationship and the vertebral theory has subsequently often been known as the Goethe-Oken theory. Goethe's pretensions are effectually disposed of by Oldfield Thomas (Encyc. Brit., 11th ed., 1911, vol. 20, p. 56).

Opinions differed, however, as to the number of hypothetical vertebræ; Goethe declared six, Oken three and later four, and this number was also accepted by Rathke in 1839, by Owen (R. 1846.1), Bruch (C. 1862.1), and by others, the highest number suggested being seven.

The theory, which had much declined, was again revived with vigor in 1848 by Owen (R. 1848.1).

In 1858, Huxley (T. H. Add. 1859.2) delivered his famous Croonian lecture on the vertebrate skull, in which he effectually disposed of the Okenian views, as applied to the segmentation of the bony skull, with the concluding statement (p. 433).

> "The perfectly ossified skull is divisible into a series of segments, whose *analogy* with vertebræ is closer the nearer they lie to the occipital region; but the relation is an analogy and not an affinity and these cephalic sclerotomes are not vertebræ."

Modern views

In 1872, Gegenbaur (C. 1864.2, iii) published his epoch-making work on the Selachian skull. In this he transferred the fundamental idea of segmentation to the chondrocranium which although forming a continuous structure in the adult Selachian, exhibits, especially behind the infundibulum, many signs of an original metameric or segmental structure. Gegenbaur conceived of the skull as composed of an anterior *prevertebral region*, chiefly formed by a forward growth around the nasal organs and including the ethmoid region, and a posterior *vertebral region* comprising the occipital, auditory, and part of the orbital regions. This latter region overlies the notochord, precisely as does the vertebral column, and it gives exit to the segmental nerves which he considered spinal nerves. He believed the fused vertebræ to number at least nine, chiefly because of the visceral arches (Bogenbildungen) which he interpreted as ventral or hæmal arch formations, serially homologous with ribs.

Stöhr (P. A. 1882.1; Zeits. Wiss. Zool., 1879, vols. 33, 34) soon added the fruitful idea that the fusion of vertebræ had progressed from front to rear; that this caudal progression is still continuing; and that it had proceeded unequally in different groups, the skull of some forms having absorbed more vertebræ than that of others.

This last idea has become further extended through the researches of Rosenberg (E. W. 1884.1, 1887.1), of Gegenbaur (C. 1887.1), and of Sagemehl (M. 1884.1). Rosenberg concluded that the correct conception of the Selachian skull is not that of a fixed size but that, for example, the cranium of Carcharias includes one vertebra more than that of Mustelus. Sagemehl going still farther, believed that, in mode of origin, the skull may be divided into (1) the *protometameric type*, found in Selachians and Amphibia, which is formed by the fusion, not of vertebræ, but of metameres or somites and (2) the *auximetameric type* of Teleostomes and Amniotes, in which the three anterior vertebræ of the vertebral column, having lost their freedom of motion through the backward projection of the parasphenoid, have been incorporated into the cranium. With these views, however, Gegenbaur is not in agreement.

Various papers on the morphology of the occipital region of the skull with especial reference to the vertebral theory. Bertini, E. 1907.1; Brachet, A. 1909.1; ★Brohmer, P. 1909.1; Drüner, L. 1905.1; Froriep, A. 1905.1,.3; ★Gegenbaur, C. 1871.1, 1887.1, **1888.1**, 1912.2; Nusbaum, J. 1908.1; Rohon, J. V. 1894.1, 1895.2; Wijhe, J. W. Add. 1889.1.

For the coalescence of vertebræ with the occipital region of the skull in various families of Ostariophysi (particularly Cyprinidæ and Siluridæ) in connection with the development and morphology of the Weberian apparatus, see that topic under Auditory Organs.

Development of the skull

"It has now been conclusively shown" (quoting from Goodrich, E. S. 1900.1, p. 11) . . . "that skeletal segments of vertebral nature do, in the course of ontogeny, and doubtless also in that of phylogeny, become embodied in the occipital region carrying with them their corresponding nerves. Originally spinal nerves thus come to pass through the cranial wall — so called spino-occipitals."

"This gradual inclusion of skeletal segments, sclerومeres, in the occipital region of the skull of fish has lately been followed in great detail from embryo to adult by [*our citations*] ★Severtzov, A. N. 1895.1, 1897.1; Hoffman, C. K. 1894.1, 1896.1; Braus, H. 1899.1; *and* Schreiner, K. E. 1902.1."

For the intimately related topic of the segmentation of the head, see Metamerism *under* Head.

Papers treating primarily of the chondrocranium of fishes. Filatoff, D. 1906.1; Gegenbaur, C. 1867.2; Veit, O. 1907.1,

Skull — *Cont'd.* 1911.1; Voskoboĭnikov, M. M. 1910.1; ★Winslow, G. M. 1898.1.

Those treating especially of the origin of the membrane bones (Deckknochen). Gaupp, E. 1903.1; Goeldi, E. A. 1884.1; *and* Walther, J. K. 1883.1.

Other papers treating both of the development of the chondrocranium and the bony skull of the Teleosts in general, and especially of Salmo. ★Böker, H. 1913.1; ★Klein, A. 1884.1; Parker, W. K. 1872.1; Pouchet, G. 1874.1; ★Rosén, N. **1910.1**; ★Schleip, W. 1903.1; ★Swinnerton, H. H. (*Gasterosteus*) 1902.1; Tikhomirov, A. A. 1885.1; Vrolik, A. J. 1873.1; Willcox, M. A. 1899.1; Ganin, M. Add. 1880.1.

MORPHOLOGICAL TOPICS

Concerning the skull

There is an extensive literature on the skull concerning the determination of the homologies of the various cranial and skull elements throughout the vertebrate and especially the Tetrapod series. This literature is obviously beyond the sphere of the present work.

Orbitosphenoid, structure. Starks, E. C. 1908.3. — *Sphenotic.* Baraldi, G. Add. 1883.1.

Morphology of the palatoquadrate in — Selachii. Allis, E. P. 1914.1. — *Dipnoi.* ★Boas, J. E. Add. 1914.1.

Fontanelles

In some fishes, certain skull bones such as the frontals and parietals fail to coalesce in the median line leaving open median pits or fontanelles.

These are fully discussed, in the skull of Placoderms and Siluridæ, by ★Dean, B. 1891.2. *This paper is reviewed by* Woodward, A. S. 1891.9. — *Conditions in Callichthys.* Klinckowström, A. 1893.2.

The Jaws

Lesser papers on the homologies of the jaw elements throughout the vertebrate series. Albrecht, P. 1883.1, 1884.1; Bardeleben, K. 1905.1–1907.1; Broom, R. 1913.4; Humphry, G. M. 1865.1; Jourdain, S. 1878.1.

The sesamoid articular, a bone present in the mandible of some fishes. ★Starks, E. C. 1916.1; Storrow, B. 1910.2.

Minor papers descriptive of the jaws in the following forms. — Amia and Hydrocyon. Brühl, C. B. 1891.1. — *Cyprinus.* Freund, L. 1909.2. — *Esox and Teuthis.* Hilgendorf, F. M. 1872.1, 1880.1. — *Hemiramphus.* Hopewell-Smith, A. 1908.1. — *Gadus.* ★Petersen, H. 1914.1.

For figures of the jaws of various sharks and rays, see Garman, S. 1913.1, *and* Radcliffe, L. 1916.1.

Latero-sensory Canals

The latero-sensory canals of fishes, traversing certain cranial bones, are remarkably constant in position, and give important and often positive evidence as to the homologies of these bones. It is generally accepted that certain bones develop in direct relation to these canals. The enclosure of the canals takes place in two distinct manners, called by Allis, plagiostomian and teleostean.

These matters, with the literature, are fully discussed in ★Allis, E. P. 1904.1.

An old paper on this subject is Stannius, F. H. 1842.3.

Morphology of the Myodome

The myodome of fishes, according to Allis, is primarily a sub-pituitary space connected with the orbit of either side or the orbital region by a canal which transmits the pituitary vein. This space secondarily acquired a wide communication with the orbits apparently by the enlargement of the eyeballs which caused a deepening of the orbits followed by the entry of certain eye-muscles into the pituitary canal and the final complete destruction by them of the wall separating the orbits from the subpituitary space. The myodome of Amia is believed to be strictly homologous (p. 193) with the cavernous and intercavernous sinuses and the Cava Meckelii, together, of the human skull.

This topic is comprehensively treated, with a full review of the literature, by ★Allis, E. P. 1909.1, pp. 183–203. *See also* Starks, E. C. 1905.2.

The Operculum

Much interest seems to have been exhibited, a century or more ago, in the morphological significance of the operculum. The following references, although not seen by us, seem to have little other than historical value.

Blainville, H. M. 1817.1,.2; Bojanus, L. 1817.1; Eichwald, C. E. 1833.1; Geoffroy-St. H., E. F. 1817.1,.2; Hollard, H. L. 1863.1, 1864.1; Lavocat, A. 1888.1; Oken, L. 1823.2. — *Operculum in Aspredinidæ.* Eigenmann, C. H. 1892.8.

Suspensorium of Jaws

To express the manner in which the first visceral or mandibular arch is connected with the skull, Huxley (T. H. 1876.1, p. 40) suggested the terms *autostylic* where the mandibular arch is "attached directly to the skull by . . . its own substance;" *hyostylic* where the hyomandibular "becomes the chief apparatus of suspension;" and *amphistylic* for the "condition of the cranium which tends to connect the two [above] by a middle form."

Subsequent research has necessitated further precision in definition, which has been supplied, with additional terms, by ★Gregory, W. K. 1904.2.

Other papers relating to the suspensorium. Carter, J. T. 1905.1; Gadow, H. 1888.1; Huxley, T. H. 1859.1; Kerr, J. G. 1908.2; Pollard, H. B. 1895.2; *and* Swinnerton, H. H. 1902.1 (p. 568).

SKULL BY GROUPS

For the complete literature reference should be made also to "Skeleton" and to "Visceral skeleton."

Cyclostomata

The skull of this group consists entirely of the chondrocranium. It is highly specialized and its parts can not readily be homologized with those of the skull of other vertebrates.

Structure of the skull of Bdellostoma, Petromyzon, and Myxine. ★Allis, E. P. 1903.2; Neumayer, L. 1898.1; ★Schaffer, J. (*Myxine*) 1901.2; Schalk, A. 1913.1.

Dipnoi

Morphology of the skull of Dipnoi in general. Allis, E. P. 1914.2; ★Bridge, T. W. 1897.1; Brühl, C. B. 1891.3; Cobbold, T. S. 1862.3; ★Fürbringer, K. **1904.2**; Boas, J. E. Add. 1914.1.

Development of the chondrocranium in — Lepidosiren and Protopterus. ★Agar, W. E. 1906.1. — *Neoceratodus.* Kravetz, L. 1911.1; Winslow, G. M. 1898.1; McGregor, J. H. Add. 1901.1.

Elasmobranchii

The Elasmobranchs "are sharply separated from all fishes except the Marsipobranchii, by the non-related condition of their exo- and endoskeleton" (Parker, W. K. 1879.2, p. 189). The skull is formed entirely by the chondrocranium. Calcification may occur in adult specimens but neither cartilage bones nor membrane bones develop.

Plagiostomi

The outstanding treatise on the Elasmobranch skull is the classical memoir (in German) of ★Gegenbaur, C. **1864.2** (iii).

An excellent general treatise in German is ★Hubrecht, A. A. 1876.3, *p.* 38 *et seq.*

Probably the most valuable memoir in English is ★Parker, W. K. **1879.2.**

Development and morphology of the Selachian skull. Allis, E. P. 1913.1, 1914.1,.3; Kölliker, R. A. 1860.4; Rabl-Rückhard, H. 1880.1; Rosenberg, E. W. 1884.1, 1887.1; ★Severtzov, A. N. 1899.1; Wijhe, J. W. 1904.1.

Structure of the skull in — Chlamydoselachus. Cope, E. D. 1884.1, 1884.9. — *Pristidæ.* ★Hoffmann, L. 1912.1. — *Ceratoptera.* Lloyd, R. E. 1908.2. — *Stegostoma.* ★Luther, A. F. 1909.1. — *Læmargus.* White, P. J. 1893.1.

For excellent figures of the skulls of various Plagiostomes, see Garman, S. 1913.1.

Holocephali

As may be inferred from the name "Holocephali," "the chimæroid cranium, instead of developing as a uniform trough-like brain-case (shark), appears, even in early condition, in a wonderfully complete form; it incloses the hindbrain, the forebrain, and the nasal region." (Dean, B. 1906.1, p. 127.)

Structure of the skull of Holocephali. Brühl, C. B. 1891.3; Hubrecht, A. A. 1876.1; ★Luther, A. F. 1909.1; Reis, O. M. 1895.2; ★Schauinsland, H. H. 1903.1.

SKULL OF TELEOSTOMI

Crossopterygii

In Polypterus, the chondrocranium is largely persistent. The sphenoid bone, according to Bridge (p. 126), is strictly homologous with the sphenethmoid of the Amphibia. No Ganoids other than Polypterus and Calamoichthys have a sphenethmoid of the Polypterine or Amphibian type.

"Polypterus," says Pollard (p. 405), "will be the most suitable type to explain the origin of perichondrial [cartilage] bones."

Morphology of the skull of Polypterus. Allis, E. P. 1900.2; Bridge, T. W. 1890.3; Budgett, J. S. 1902.2; Owen, R. 1863.1; ★Pollard, H. B. 1892.2; Traquair, R. H. 1871.3.

Morphology in Calamoichthys. Supino, F. 1914.2.

Chondrostei

Homologies of cranial bones of Polyodon. Allis, E. P. 1903.3; Bridge, T. W. 1878.1.

Development and morphology of the skull of Acipenser. Luther, A. F. 1913.1; Maggi, L. 1899.1; ★Parker, W. K. 1873.1, 1881.1.

Holostei

Morphology, development, and homologies of bones of the skull of Amia and of Lepidosteus. ★Allis, E. P. 1897.1, 1898.3, 1899.2; Bridge, T. W. 1877.1; ★Parker, W. K. 1882.1; ★Sagemehl, M. **1884.1**; Schreiner, K. E. 1902.1; ★Veit, O. 1907.1, **1911.1.**

Teleostei

Additional references to the skull of Teleosts will be found *under* Skeleton, *below the caption* "Osteology of Teleostei."

Sub-order Acanthopterygii

Cranial anatomy of the mail-cheeked fishes, Loricati or Scorpænoidea. ★Allis, E. P. 1907.1, **1909.1.**

Cranial anatomy of Scomber. ★Allis, E. P. 1903.4; Dewitz, J. 1904.1.

Skull of Pleuronectidæ. Brühl, C. B. 1891.5; ★Cole, F. J. & Johnstone, J. 1901.1; Klein, E. E. 1868.1. —*For changes in skull of flatfishes during metamorphosis and rotation of eye, see under* Pleuronectidæ *in the Systematic Section.*

Structure of the skull of — Anarrichthys. Adams, L. A. 1908.1. — *Regalecus.* Benham, W. B. & Dunbar, W. J. 1906.1. — *Labrax.* Brühl, C. B. 1891.5. — *Sebastodes.* Cramer, F. 1895.1. — *Cyclopterus and Liparis.* Hilgendorf, F. M. 1878.1. — *Lucioperca.* Pugliesi, E. 1911.1. — *Echeneidæ.* Regan, C. T. 1912.2. — *Ruvettus.* Supino, F. 1901.1 (iii). — *Trichiuridæ.* Supino, F. 1904.3.

Cranial characters (taxonomic) of Sparoid genera Calamus, Diplodus, Archosargus, and Stenotomus. Gill, T. N. 1883.1,.3.

Structure of the skull respectively of Pomatomus and Hoplostethus; Percidæ and Triglidæ; and Trachinidæ. Supino, F. 1901.1 (iv), 1904.3, 1908.3.

Sub-order Apodes

Skull of Muraenidæ. Cannarella, P. 1898.1; Ficalbi, E. 1886.1; Jacoby, L. 1867.1.

Skull of — Anguilla. Parker, W. K. 1871.2. — *Amphipnous.* Regan, C. T. 1912.1. — *Gastrostomus.* Zugmayer, E. 1913.1.

Sub-order Haplomi

Skull of — Esox. Arendt, E. 1822.1; ★Walther, J. K. 1883.1; Csengó, N. Add. 1914.1. — *Scopelus.* Supino, F. 1901.1 (i).

Skull — *Cont'd.*

Sub-order Malacopterygii

Skull of Mormyridæ. Erdl, M. P. 1847.1; Pappenheim, P. 1907.1; Ridewood, W. G. 1904.2.

Skull of Osteoglossidæ. Bridge, T. W. 1895.1; Ridewood, W. G. 1905.2.

Skull of Salmonidæ. (See also above under "Development.") Boulenger, G. A. 1895.10; ★Parker, W. K. 1872.1.

Structure of the skull of — Alepocephalus. Gegenbaur, C. 1878.4. — *Albula.* Gill, T. N. 1907.6. — *Aulastomatomorpha.* Lloyd, R. E. 1906.1. — *Chauliodus.* Supino, F. 1901.1 (i).

Cranial osteology respectively of Elopidæ and Albulidæ; Notopteridæ and Hyodontidæ; Clupeidæ; Pantodontidæ and Phractolaemidæ; and Gonorhynchidæ. Ridewood, W. G. 1904.1,.2, 1905.1,.2,.3.

Sub-order Ostariophysi

Skull of Characinidæ and Cyprinidæ. Jaquet, M. 1902.1; ★Sagemehl, M. 1884.1; Gervais, F. L. Add. 1850.1.

Skull of — Siluridæ and Loricariidæ. Dean, B. 1891.2. — *Loricaria.* Goeldi, E. A. 1884.1. — *Siluridæ.* Neumayer, L. 1908.1. — *Clarias.* Schelaputin, G. 1906.1. — *Hypophthalmus.* Wright, R. R. 1886.1.

Skulls of fishes
of various sub-orders

Lota. Bonsdorff, E. J. 1845.1. — *Exocœtus.* Lasdin, W. 1913.1,.2. — *Syngnathus.* McMurrich, J. T. 1883.1. — *Lyomeri (Taxonomic relations).* Regan, C. T. 1912.5. — *Macrourus.* Supino, F. 1901.1 (ii). — *Lophobranchii.* Supino, F. 1904.3. — *Pediculati and Plectognathi.* Supino, F. 1904.3, 1908.3. — *Trachinidæ.* Supino, F. 1908.3. — *Lophius.* Morrow, R. Add. 1882.1.

SLEEP OF FISHES

For the so-called "summer," and "winter sleep" of fishes, *see* respectively *under* Aestivation, *and* Hibernation.

Comments, notes, observations, and miscellaneous items on sleep in fishes, the question whether fishes do sleep, etc. Bonvoisin, L. 1877.2; Capel, C. C. 1878.1; Eisig, H. 1883.2; Hughes, W. R. 1874.1; Reinhart, H. 1911.1–1913.1; Reuss, H. 1911.1; Schmid, B. 1911.1; Schulze, L. 1913.2; Shufeldt, R. W. 1900.3; Verrill, A. E. 1897.1; Fraenkel, F. Add. 1909.1; Krüger, B. Add. 1914.1; Voigt, G. Pre-Linn. 1721.1.

Observations on the position of fishes during sleep. Carazzi, D. 1913.2; Krüger, B. 1913.8; Leeke, – 1912.1; Möbius, K. A. 1867.1; Romeis, B. 1911.1; Werner, Franz 1911.1.

Experiments with special apparatus indicate greater activity during the day, with periods of repose at night. Polimanti, O. 1911.2; ★Szymanski, J. S. 1914.1.

SMELL (*OLFACTORY SENSE*)

For the structure of the organs of smell, *see* Olfactory organs.

For a résumé of our knowledge on the sense of smell in fishes, see ★Parker, G. H. & Sheldon, R. E. **1913.1.**

Researches on the olfactory sense of fishes; necessary distinctions between smell and taste and a common chemical sense, etc. (Conclusions that olfactory sense exists; in dogfish (Mustelus) this is lost when nostrils are plugged with cotton.) Parker, G. H. 1910.3, 1911.1,.2, 1912.1, 1914.1,.2; Sheldon, R. E. 1909.3, 1911.1; Parker, G. H. & Stabler, E. M. Add. 1913.1.

Existence of the sense of smell in — Balistes. Baglioni, S. 1909.2, 1910.1, Add. 1909.1. —*Spheroides.* Copeland, M. 1912.1. — *Cyprinus.* Herklotz, E. O. 1864.1.

Conclusion that fishes do not possess a sense of smell. Nagel, W. A. Add. 1894.1.

Miscellaneous papers on the olfactory sense in fishes. Desvignes, – 1835.1, 1836.1; Doflein, F. J. 1911.1; Duméril, A. M. 1807.3, 1858.1; Fohmann, V. 1835.1; Geoffroy-Saint-Hilaire, E. F. 1825.1; Kammerer, P. 1911.1.

SOUND PRODUCTION AND SOUND PRODUCING ORGANS

For an analysis of the methods of sound production by fishes, see Bridge, T. W. 1904.1, pp. 355–365.

Sound production. General treatises. Dufossé, A. 1874.1; Sørensen, W. E. 1884.1.

General researches on sound production. Dufossé, A. 1858.1, 1866.1, 1868.1, 1872.1; Duméril, A. H. 1863.2; Robin, C. P. 1872.1,.2; ★Müller, J. **1857.1;** ★Weiss, O. Add. 1914.1.

Apparatus of sound production. —*Extrinsic muscles of air bladder producing sounds.* Bridge, T. W. & Haddon, A. C. 1894.1; Skomorowski, T. 1875.1; ★Sørensen, W. E. 1879.1,.2,.3, 1895.1; Tower, R. W. 1908.1; Bridge, T. W. Add. 1893.1.

Muscles forming a diaphragm inside air bladder. Moreau, F. A. 1864.2, 1876.3.

Stridulating apparatus, producing sounds by grating of spines against parts of skull, etc. —*Balistes.* Möbius, K. A. 1889.1. — *Callomystax.* Haddon, A. C. Add. 1881.1.

Miscellaneous papers *including popular accounts, etc., on "musical fishes," "song of fishes," "voice," etc.*

Text in Dutch. Harting, P. 1862.2, 1874.1, 1880.3; Lubach, D. 1859.1, 1872.1.

Text in English. Abbott, C. C. 1877.1, 1884.1; Cobb, J. N. 1908.4; Evermann, B. W. 1909.1; Galton, J. C. 1874.1; Gill, T. N. 1881.3; Girard, C. F. 1889.2; Holder, C. F. 1902.1; Parish, C. 1871.1; Spicer, W. W. 1871.1; Tower, R. W. 1906.1; Günther, A. C. Add. 1870.1; Kingsley, M. H. Add. 1901.1; Thompson, J. Add. 1830.1; Athenæus, N. Pre-Linn. 1680.1; Anon. 368, 506.

Text in French. Coupin, H. 1904.1; Santini, E. 1898.1, 1899.1.
Text in German. Landois, H. 1873.1; Martens, E. 1876.2; Mettenheimer, C. F. 1858.1; Simroth, H. R. 1897.1; Anon. 262, 369, 370, 505.
Text in — Spanish. Balaguer y Primo, D. F. 1878.1. — *Finnish.* Wikström, D. A. 1889.1. — *Swedish.* Zur Mühlen, M. 1911.7.

Sound production by various fishes. — *Sciænidæ, including Drumfish.* Adams, A. 1861.1, Add. 1848.1; Agassiz, J. L. 1850.4; Smith, H. M. 1905.1. — *Siluridæ.* Agassiz, J. L. 1850.4; Brüning, C. 1913.4; Jenyns, L. 1842.1; Jobert, C. 1880.1; Maas, K. 1914.1. — *Misgurnus.* Budge, J. 1873.1. — *Perch.* Hamilton, W. R. 1889.1. — *Barbus.* Peal, S. E. 1880.1. — *Purring gourami, Ctenops.* Schäfer, P. 1915.1; Schiebold, A. 1912.1; Dorn, R. Add. 1914.1. — *Herring.* Murray, J. Add. 1831.1, 1833.1.
Sound producing fishes of various localities. — *Singing fish of Batticaloa, Ceylon.* Drieberg, C. 1908.1; Newman, E. 1860.1; Pearson, J. 1912.3. — *Musical fishes of Borneo.* Anon. 603; Beccari, O. Add. 1904.1; St. John, S. Add. 1844.1.
Musical fishes of South America. Lubach, D. 1862.1; Onffroy de Thoron, E. V. 1866.1; Thoron, O. de 1861.1, 1870.1; Tesson, A. Add. 1884.1.

SPERMATOZOA

For the female reproductive elements, *see* Ova and ovum. *For* Fertilization and related topics, *see under* Embryology.

Discovery of spermatozoa (in codfish). Leeuwenhoek, A. Pre-Linn. 1702.1.

Behavior or movements of the spermatozoa of fishes: *The characteristic rheotropism (upstream) of the mammalian spermatozoön is absent in the sperm of ordinary oviparous Teleosts having external fertilization, in which the sexual products are simply cast into the water, and where such rheotropism would be of no value, as shown by the careful researches of* Adolphi, H. 1906.1.

Chemical composition. *For an exhaustive treatise on the chemistry of spermatozoa, with a full bibliography, consult* ★Burian, B. *in* Ergebnisse der Physiol., (Asher u. Spiro), 1904, 3. Jahrg., 1 Abt., 48–106; 1906, 5. Jahrg., 1 Abt., 768–846.
Early researches on chemistry of spermatozoa. Baumhauer, E. H. 1846.1; Fourcroy, A. F. & Vauquelin, L. N. 1807.2; Gobley, - 1851.1.
General discussion of proteins of spermatozoa. ★Kossel, A. Add. 1913.1.
Histones: basic proteins intermediate between protamines and true proteins. — Scombron of mackerel sperm. Bang, I. 1899.1. — *Lotahistone of Lota.* Ehrström, R. 1901.1. — *Centrophorus histone.* Kossel, A. 1907.1. — *Gadushistone of cod.* Kossel, A. & Kutscher, F. 1900.1.
Protamines: designated by Kossel as the simplest proteins, found only in combination with nucleic acids in spermatozoa of fishes. Various papers, chiefly on salmine of salmon sperm. Dezani, S. 1908.1; Kurajeff, D. 1899.1, 1901.1; Malenück, W. D. (*Sturine*) 1908.1; ★Miescher-R., F. 1881.1, 1896.1, Add. 1897.1; Piccard, J. 1874.1; Weiss, F. 1907.1; Zacharias, E. O. 1898.3; Schmiedeberg, O. Add. 1899.1. — *Discovery of protamines.* Miescher, F. Add. 1874.1.
Cleavage products — Agmatine derived from hydrolysis of herring sperm. Kossel, A. 1910.1. — *Purine bases: adenine, guanine, and sarkine or hypoxanthine.* Levene, P. A. & Mandel, J. A. 1906.1; Piccard, J. 1874.1; Schindler, S. 1889.1.

Duration of virility. *Effects of radium.* Oppermann, K. 1913.1. — *Effects of temperature, chemicals, bile of Anguilla, etc., on shark sperm.* Trois, E. F. 1883.2.
It is now well known, chiefly through the experiments of Quatrefages and of Henneguy, that the life of the spermatozoa of freshwater fishes, after their expulsion into the water at the time of fertilization, is very short, being not more than one minute in the trout, according to Henneguy. These experiments were made for the fish-culturists, who, now, in order to prolong the virility of the sperm, generally avoid mixing the milt with water when fertilizing the eggs. *References as follows:* Henneguy, L. F. 1877.1; Quatrefages, J. L. 1853.1. — *Review of subject including marine fishes.* ★Reighard, J. E. 1893.2. — *Exps. with salmon sperm.* Rutter, C. 1902.1, 1904.1.
Retention of virility in salmon milt when unmixed with water. Atkins, C. G. 1874.1, 1879.1; Simmonæs, J. O. 1896.1. — *Virility retained after 21 hours in transit.* Calderwood, W. L. 1909.1.
Vrasski, V. P. claimed such endurance up to six days. (*Cf. acc't in* Vœlkel, P. 1870.1.) *He originated the " Russian, or dry method of impregnation." — For this method, see* Artificial fertilization, *under* Pisciculture.

Masses of spermatozoa or spermatophores. *Spermatophores (said to possess an external investing membrane) of the oviparous Chimæroid, Callorhynchus.* Parker, T. J. 1892.1.
Sperm aggregations of the viviparous Pœciliidæ, lacking an external membrane. Philippi, E. 1907.1, 1908.1. — *Summary of this.* Henn, A. W. 1916.1.
For related topics, such as manner of copulation, etc., see Viviparity *under* Reproduction.

Spermatogenesis. *Miscellaneous and general.* Ovsyannikov, F. V. 1869.1; Popoff, N. 1909.1. — *Nurse or Sertoli-cells, functions.* Peter, K. 1898.1; Stéphan, P. 1902.2,.4,.5.
Spermatogenesis in — Lepidosiren. Agar, W. E. 1911.1, 1912.1. — *Myxine.* Cunningham, J. T. 1892.6; ★Schreiner, A. &

Spermatozoa — *Cont'd.*
Schreiner, K. E. **1905.1,** 1906.1. — *Chimæra.* Stéphan, P. 1903.1.

Spermatogenesis in Elasmobranchs, chiefly Selachii. Hallmann, E. 1840.1; Hermann, F. 1897.1, 1898.1; Hermann, G. 1881.1; La Valette, St. G., A. 1878.1; ★Moore, J. E. 1895.1; Rawitz, B. 1898.1; ★Sabatier, C. P. 1882.1, 1895.1, 1896.2; Sanfelice, F. 1888.1; Schreiner, A. & Schreiner, K. 1906.1; Semper, C. G. 1875.3; Stéphan, P. 1902.2,.4, 1903.2. — *Middle piece, origin.* Suzuki, B. 1899.1.

Early work on the origin of spermatozoa in Selachii. Hallmann, E. 1840.1; Lallemand, F. 1841.1; Martino, A. 1846.1, 1848.1.

Development of atypical or teratological forms in Selachii. Broman, I. 1902.1; Stéphan, P. 1902.3.

Structure of spermatozoa. *Shape, size, etc., of mature or functional spermatozoa of various fishes.* ★Ballowitz, E. 1890.1. — *Amphioxus.* Bert, P. 1866.2. — *Petromyzon.* Ballowitz, E. 1905.2; Bory de Saint-Vincent, J. B. 1822.2; Gulliver, G. 1875.2. — *Carp.* Dujardin, F. 1837.1. — *Elasmobranchii.* ★Retzius, M. G. 1902.1, 1909.1. — *Leptocardii, Teleostei, and Ganoidei.* Retzius, M. G. 1905.2.

SPINAL CORD

Much additional literature on the spinal cord, which it has not been practicable to separate from that relating to the brain, will be found under the heading "Central nervous system" *under* Nervous system. *See also* Brain.

Generalia. — "*Lateralstränge,*" *Teleosts.* Haller, B. 1910.1. — *Preservation of spinal cord in fossil fishes.* Reis, O. M. 1894.2. — *Circulatory system of spinal cord, development and comparative anatomy.* ★Sterzi, G. 1904.1.

Anatomy and morphology. *Miscellaneous and general.* Kölliker, R. A. 1858.1; Mauthner, L. 1859.1.

Amphioxus. Stendell, W. 1914.3; Wolff, M. 1907.1.

Cyclostomata (Ammocœtes and Petromyzon). Carus, C. G. 1828.1; Freud, S. 1879.1; ★Kolmer, W. 1905.2; Ovsyannikov, F. V. 1864.3, 1903.1; Reissner, E. 1860.1; ★Tretjakoff, D. **1909.2.**

Plagiostomi. ★Kalberlah, F. 1900.1. — *Pristiurus and Rays.* Lenhossék, M. 1892.1, 1894.2; Retzius, M. G. 1895.3; Stieda, L. 1871.1, 1872.2, 1873.4. — *Myliobates.* Schacherl, M. 1902.1.

In Teleostomi. ★Haller, B. **1895.2,** Add. 1896.1; Ovsyannikov, F. V. 1864.3.— *Orthagoriscus mola.* ★Haller, B. **1891.1;** Tagliani, 1894.1, 1895.1. — *Carassius.* Hirsch, J. 1912.1. — *Mormyridæ.* ★Marcusen, J. **1864.1.** — *Acipenser.* Pavlovskii, E. 1895.1. — *Esox.* Stieda, L. 1861.1. — *Anguilla.* Tiegel, E. 1878.1. — *Lophius.* Wyman, J. 1854.1, *Cyclopterus.* 1854.4. — *Trigla.* Rejsek, J. Add. 1898.1.

Anatomy of particular parts or structures of the spinal cord. *Accessory lobes in — Prionotus.* Herrick, C. J. 1907.3. — *Teleostei.* ★Usov, M. M. 1886.1.

Terminal portion of spinal cord, relation to notochord in — Amphioxus. Lvov, V. N. 1893.2. — *Amphioxus, Myxine, and Petromyzon.* Retzius, M. G. 1891.1, 1892.2, 1895.2. — *Vertebrates in general.* Schwarz, D. 1889.1; Studnička, F. K. 1895.3; Henneguy, L. F. Add. 1882.1. — *Caudal intumescence (source of filum terminale).* Rauber, A. 1876.1. — *Terminal ganglion, Cyprinus.* Weber, E. H. 1827.3.

Development and origin. — *Cells in anterior roots.* Debeyre, A. 1907.1. — *Posterior nerve roots in Petromyzon.* Freud, S. 1877.2. — *Development of spinal cord, Amphioxus.* Wolff, M. 1907.1.

For early stages in the formation of the spinal cord, see Formation of embryo, *and* Medullary tube *under* Embryology.

Histology and histogenesis. Ovsyannikov, F. V. 1854.1; Retzius, M. G. 1893.2; ★Studnička, F. K. **1895.2.** — *Cells for light perception.* Boeke, J. 1902.2. — *Subpial layer.* Nemiloff, A. 1912.1. — *Intersection of nerve fibers.* Vulpian, E. F. 1864.2.

Histology and histogenesis in various fishes. — *Tinca.* Jacobsohn, L. 1911.1. — *Teleosts.* ★Kolster, R. **1898.1.** — *Orthagoriscus.* Paladino, G. 1913.1. — *Trout.* ★Gehuchten, A. 1895.1; Rohon, J. V. 1884.1.

Giant ganglion cells (Rohon-Beard cells) in spinal cord of — Heterosomata and Pterophryne. Dahlgren, U. 1897.1, 1898.1. — *Trutta.* Gehuchten, A. 1896.1. — *Coregonus and Catostomus.* Johnston, J. B. 1900.1. — *Perca.* Kolster, R. 1898.2. — *Selachii.* Neal, H. V. 1911.1. — *Ctenolabrus.* Sargent, P. E. 1898.1,.2. — *Amphioxus and Solea.* Tagliani, G. 1897.1, 1898.1.

"*Hinterzellen*" *in fishes.* Gehuchten, A. 1897.1.

Mauthner's fibers in — Salmo. Beccari, N. 1908.1. — *Teleostei.* Kolster, R. 1898.3; Marano, A. 1911.1. — *Chimæra.* Solger, B. F. 1899.1. — *Anamnia.* ★Tagliani, G. 1905.1.

Physiology, normal and experimental. Bickel, A. Add. 1897.1, 1900.1. — *Rate of nervous impulses in spinal cord, Bdellostoma.* Carlson, A. J. 1904.2. — *Experiments to ascertain influence on heart action.* Clift, W. 1815.1.

SPLEEN

Anatomy. General accounts. ★Phisalix, C. **1885.1;** Rathke, M. H. 1837.2.

Anatomy in — Amiurus. Mackenzie, T. 1884.1. — *Petromyzon.* Mayer, A. F. 1832.1. — *Selachii.* Neuville, H. 1898.1. — *Anguilla.* Phisalix, C. 1883.1.

Development. General researches. ★Choronshitsky, B. 1900.1; Kupffer, C.

W. 1892.1; ★Piper, H. 1902.2; Poso, O. 1906.1.

Development in — Teleosts. ★Laguesse, G. E. 1887.1, **1890.2.** — *Ceratodus.* Neumayer, L. 1904.1,.3. — *Acipenser.* Nicolas, A. 1904.1. — *Amia.* Piper, H. 1902.1,.3, 1903.1. — *Selachii.* Ruffini, A. 1904.1.

Histology. Hoyer, H. 1892.1. — *Of spleen capsule, Selachians.* Laguesse, G. E. 1903.1,.2, Add. 1888.1.

Physiology. ★Whiting, A. J. **1897.1;** Phisalix, C. 1885.1. — *Changes undergone in salmon spleen while in freshwater.* Miescher-Ruesch, F. 1881.1. — *Role in formation of blood.* Phisalix, C. 1902.1.

Physiological effects of removal. — Tissue hyperplasia following removal of spleen. Drzewina, A. & Pettit, A. 1904.1. — *Fusiform cells, occurrence in blood after removal of spleen.* Pettit, A. 1904.2,.3.

SUPRARENAL ORGANS (*SURRENAL SYSTEM OF FISHES*)

Including the "Interrenal body" (or cortical tissue), and the "Suprarenal bodies" (medullary tissue) or Chromophile bodies.

It is now well established that the mammalian adrenal or suprarenal organs, represented by an asymmetrical pair of bodies which surmount the kidneys, each of which is composed of a central medullary tissue and an outer cortical tissue, are represented in fishes by two morphologically independent structures. The determination of these homologies has been a matter of gradual growth but is largely due to Swale Vincent.

Introductory

Because of the importance of the subject from the medical standpoint, the structure and especially the functions of the suprarenals, in all groups of vertebrates and especially in the mammals, has, in recent years, been made the subject of profound and exhaustive inquiry. The number of titles of such researches, included in the bibliographies of the general works about to be mentioned, mounts into the hundreds.

In order to properly orient the following account, which pertains exclusively to fishes, reference may advantageously be made to the following general summaries of our present knowledge of the suprarenal system, which include also much material on fishes.

These are ★Artur Biedl's "Innere Sekretion" *and its English translation, and* ★Swale Vincent's "Internal Secretions and the Ductless Glands."

Principal literature

The most recent summary (in German), of the morphology and development of the suprarenal system in vertebrates, with extensive bibliography, is ★Poll, H. **1906.1.**

For the best papers in English, although somewhat obsolete, see ★Vincent, Swale 1896.1–1907.1. *An excellent historical résumé and numerous outline drawings of these organs in various fishes are given in* ★Vincent, S. **1898.1.**

Historical résumé

In man, the suprarenals were first recognized as separate organs, by Eustachius, in the year 1563.

"The earliest account respecting these bodies in fishes [quoting from Collinge & Vincent, 1897.1, with necessary adaptations in reference numbers] is that given in 1819 by Retzius (A. A. 1819.1) who described them in certain species of dog-fish and skate. Stannius in 1839 (1839.2) discovered similar bodies in teleostean fishes, and in 1846 (1846.2) he gave a general account of them in elasmobranchs, teleosts, and the sturgeon. [They have been subsequently very generally known as the "Corpuscles of Stannius."] In the same year Ecker verified Stannius' observations and gave a description of the minute anatomy of the bodies. Hyrtl (C. J. 1851.2) and Leydig (F. Add. 1851.1) contributed further papers to the subject, the former dealing with teleosts, and the latter with *Chimæra*.

"In 1852 Frey published a general résumé of what was known of these bodies, in Todd's Cyclopedia. Leydig in 1852 (1852.1) pointed out their segmental arrangement; and a further contribution was made by Stannius. In 1875 Semper (C. G. 1875.3), in a very valuable paper, emphasised the importance of the segmental arrangement. F. M. Balfour in 1878 (1878.1) gave an account of the morphology and development of the suprarenal bodies in elasmobranchs in his well known 'Monograph.' It is to this writer that we owe the term 'interrenal.' A description of the suprarenals of Amiurus was published by M'Kenzie in 1884 (T. 1884.1)."

An early paper, not seen by us, is Jacobson, L. L. 1828.1.

Suprarenal organs of Elasmobranchii

It was in this group that the two distinct sets of structures which have been called "suprarenals" were first distinguished.

The one type, first noticed by Retzius (A. A. 1819.1), who called it a "suprarenal" because of its resemblance in texture to the suprarenal of birds, "is an 'ochre-yellow' rod-shaped structure, paired in the Rays, unpaired in the Sharks, lying usually in the region of the posterior part of the kidney but sometimes extending as far forward as its anterior extremity" (Vincent, S. 1898.1, p. 53).

Somewhat later, Leydig (F. 1852.1) insisted that the so-called axillary hearts of Duvernoy (G. L. 1837.1) and their continuations on the sympathetic ganglia were the true suprarenals. These segmentally arranged bodies described by Leydig are, in the words of Vincent, "paired bodies, placed on the intercostal or parietal branches of the aorta, and extending in many cases throughout the whole length of the abdominal cavity."

Balfour in order to distinguish the two sets of structures applied the term "interrenal" to the first and limited the term "*suprarenal*" to the *segmentally-arranged* bodies. He believed that he could distinguish medulla and cortex in the latter and was inclined to view the "suprarenals" as homologous with the mammalian suprarenal.

It is now almost generally admitted that the mammalian suprarenal is a compound organ, of which the *medullary* (or chromophile tissue) is derived from or is homologous with the *paired segmental* bodies, while the *cortical* tissue is homologous with the *interrenal* bodies.

The determination of these homologies we owe largely to Vincent. From its histological appearance, he noted (1898.1, p. 79) the resemblance or "analogy" of the interrenal tissue of Elasmobranchs to the mammalian cortical tissue and concluded that it possessed a "secretory nature." About the same time, but quite independently, Diamare (V. 1899.1) reached almost identical conclusions.

When referring, at one time, to the probability of the correspondence of the interrenal

Suprarenals — *Cont'd.*

to the cortex of the mammalian suprarenal (Vincent, S. 1897.1, p. 46), Prof. Schäfer suggested that the matter be tested physiologically as given below under "Physiological action." The results, as there indicated, firmly established these homologies.

Development of the suprarenals

It is now well established that the chromophile (medullary) bodies and the interrenal (cortical) tissue are of different embryonic origin, the former, as first established by Balfour (F. M. 1878.1), being derivatives of the sympathetic ganglia, and the latter arising from thickenings of the cœlomic epithelium (Wijhe, J. W. van 1889.1).

The most valuable recent summary of the development of the suprarenal organs in vertebrates, with a full review of the previous literature, is ★Poll, H. **1906.1.**

Other papers on their development or morphology in Elasmobranchii. Diamare, V. 1899.1, 1905.1; ★Grynfeltt, E. 1902.1, .2,.3, **1903.1,** 1903.2; Kohn, A. 1898.1, 1899.1; ★Minervini, R. 1904.1; Wijhe, J. W. 1888.1,.2, 1889.1; *and* Zuckerkandl, E. 1906.1.

Others relating to Teleosts. Diamare, V. 1895.1, 1899.1; Huot, A. 1897.1, 1898.1; Pettit, A. 1910.1; *and* Srdinko, O. V. 1903.1 (i).

Fallacious theories of development

In 1827, Rathke (M. H. 1827.1) put forward the view that possibly the pronephros of Cyclostomes represents the suprarenal bodies of the Gnathostomata. Evidently quite independently, Weldon (W. F. 1884.1,.2) after a study of the pronephros of Bdellostoma, reiterated these views. Grosglik (S. 1885.1) developed a somewhat similar view, considering the "head-kidney" of Teleosts to consist of two parts, the degenerated pronephros and the cortical part of the suprarenals. These views have been fully discussed by Collinge & Vincent (1896.1) and by Vincent (S. 1898.1) who believe that there is no relation, other than that of position, between the suprarenal organs and the renal organs.

More recently, Aichel (O. 1900.1,.2), who homologizes the Selachian interrenal alone with the mammalian adrenal, has derived both parts of the mammalian adrenal from the mesonephric nephrostomes. However, it is now generally stated (Poll) that there is no relation between the renal and suprarenal organs.

Suprarenal organs of other groups

Histology of the suprarenals

The medullary substance possesses a decided chromaffinity, and when treated with salts of chromic acid (potassium bichromate), it takes on a deep yellow or brown coloration due to the presence of adrenalin. Because of this distinctive reaction, the medullary substance has been termed "Chromophil" (Stilling); "Chromaffin" (Kohn) and "Phaeochrome" tissue (Poll, 1906.1, p. 444). As applied to fishes, this method seems to have been first used by Semper (C. G. 1875.3, p. 228).

The coloring substance, because of its lipoid content, on treatment with osmic acid, gives a characteristic black color. This method seems first to have been used, with fish material, by Chevrel (R. 1890.1).

By the use of these characteristic stains, Giacomini has successfully demonstrated the occurrence of chromophile (medullary) and interrenal (cortical) tissue in all classes of fishes.

Suprarenal organs of Cyclostomata

Giacomini (E. 1902.1, 1904.2), using the chrome reaction to identify the tissues, demonstrated the existence of chromophile tissue as a row of small bodies extending along the aorta and its lateral branches from the second branchial to the end of the post-anal regions. The interrenal (cortical) tissue consists of scattered islets, often composed of only two or three cells, which lie in the tissue on the lateral and ventral aspects of the cardinal veins.

Gaskell (J. F. 1912.1) has since confirmed the existence of chromophile tissue by physiological methods (*see below*), since extracts of this tissue produce a characteristic rise of blood pressure in the cat, which can be matched by measured adrenalin injections.

Suprarenal organs of Teleostomi

Extending his researches, Giacomini has since demonstrated the presence of chromophile and interrenal tissue in Teleosts(1902.3); Acipenser (1904.1); Amiurus (1905.1); both larval (Leptocephalus) and adult eel (Anguilla), 1908.2,.4, 1909.3; Salmo (1910.1, 1911.1); Cyprinidæ (1911.2); Lophobranchii (1911.3), etc.

In general, interrenal tissue is found in the "Corpuscles of Stannius," which are small bodies, either paired or unpaired, situated at the posterior end of the kidney, and also (Anguilla, Esox, Tinca, Trutta) in the "anterior interrenal organ" which is a single body situated at the anterior edge of the pronephros and attached to the anterior and posterior cardinal veins.

Chromophile tissue cells occur in the walls of the cardinal veins, and also distributed between the lobes of the anterior interrenal organ.

Mulon (P. 1914.1) has examined chemically the anterior interrenal organ of Teleosts and finds it apparently devoid of pigment and cholesterol, thus differing profoundly from other vertebrates. However, the cytological details are essentially similar and he concludes that it is homologous with the mammalian cortex.

Suprarenal organs of Dipnoi

Giacomini (E. 1906.1) has also demonstrated the presence of chromophile cells in *Protopterus*, grouped into small paired bodies attached to the intercostal arteries throughout the trunk region, also in the walls of the posterior cardinal vein and the left azygos vein. No trace of interrenal tissue could be found.

Physiological action of suprarenal tissue

It is now well known, through the researches of Oliver and Schäfer (Journ. Physiol., 1895, vol. 18, p. 230) and of others, that saline extracts of the suprarenal capsules when injected into the blood vessels of a living animal, produce definite and characteristic results, shown especially by a marked rise in blood pressure. The extract of the medulla only acts in this way, the cortical substance being practically inactive. The active principle of the medullary or chromophile tissue extracts has subsequently been isolated as epinephrin or adrenalin.

Using this principle, Vincent (S. 1897.1) showed that filtered saline extracts of the segmentally arranged "suprarenals" of Elasmobranchs (Scyllium and Acanthias) contracted the blood vessels of the toad to an enormous degree while extracts of the interrenals and of the Teleostean "suprarenals" produced no effect. He thus concluded that the segmental bodies are homologous with the medullary tissue of the mammalian suprarenal while the interrenal corresponds to the mammalian cortical tissue.

Vincent (S. Add. 1897.1) later demonstrated that injection of the extract of the paired segmental bodies of Elasmobranchs profoundly influences the blood pressure in dogs and cats, while extracts of the interrenal tissue are without effect. These results have been confirmed by Biedl & Wiesel (Archiv. f. d. ges. Physiol., 1902, vol. 91, pp. 434–461).

Functions of the suprarenals

Brown-Séquard in 1856 first showed that removal of suprarenals in mammals is followed by death, usually in two or three days, and that the symptoms preceding death are those of extreme muscular prostration. This likewise seems to be the case with fishes.

Vincent (S. 1898.3,.4) has extirpated the "suprarenals" (*i. e.* the interrenal or cortical tissue) in the eel. One specimen survived 28 days after the operation; another 64, and a third was killed on the 119th day. From these results, he assumed "that the cortical gland is not absolutely essential to the life of the animal."

A compensatory hypertrophy of the remaining "suprarenal," after one had been removed from an eel, has been described by Pettit (A. 1896.2).

The results of Vincent and of Pettit have subsequently been invalidated by the discovery in the eel by Giacomini (E. 1908.2) of additional interrenal tissue situated at the anterior edge of the pronephros and attached to both the anterior and posterior cardinal veins.

Contrary to the results of Vincent, Biedl (A. 1912.1) found that in the skate (Torpedo and Raja), if the interrenal body is removed, the fishes grow progressively weaker after about a week and become much paler in color, scarcely moving and refusing all food after from 14 to 18 days. They usually died within three weeks after the operation with all the symptoms of general prostration.

TACTILE ORGANS (*INCLUDING SENSE OF TOUCH*)

See also Lateral line system, Senses and Sense Organs.

Structure and function. ★Jobert, C. 1871.1, **1872.1**, 1873.1. — *Acipenser.* Ovsyannikov, F. V. 1872.3.

Physiology of organs of touch. Baglioni, S. 1909.2, 1910.1, Add. 1909.1.

Barbels. Numerous unrelated species of fishes possess filiform tactile processes (barbels) on either dorsal or ventral or both lips.

References to the structure or functions of the barbels have appeared for the following forms. — *Peristedion.* Jourdan, E. 1890.1. — *Mullus.* Lo Bianco, S. 1907.2. — *Siluroids.* ★Pollard, H. B. 1905.1. — *Polyodon.* Wagner, G. 1904.1. — *Mullus, Motella, Blennius, and Trigla.* Zincone, A. 1876.1.

Fins of Motella used as feelers. Bateson, W. Add. 1890.1.

Oral cirri or tentacles of Amphioxus. Klaatsch, H. 1898.2.

Supra-orbital tentacles of Blennius. Baylis, H. A. 1914.1.

TASTE (*GUSTATORY SENSE*)

For the structure of the organs of taste, *see* Gustatory organs.

For the most comprehensive works on the sense of taste in fishes, see ★Herrick, C. J. **1904.1**, *and* ★Nagel, W. A. Add. **1894.1**.

For additional references, see Herklotz, E. O. 1864.1; Parker, G. H. 1908.2, 1912.1; Plehn, M. 1905.3; Herrick, C. J. Add. 1902.2; Parker, G. H. & Stabler, E. M. Add. 1913.1.

Vibratile dorsal fin of Motella creates water currents into the dorsal fin groove, which is lined with taste buds and is a food detecting organ. Thomson, J. S. 1911.1, 1912.1.

TAXONOMY OF FISHES

For the taxonomy of particular groups of fishes, *see* under these groups in the Systematic section.

Number of species of fishes known (estimated). — *Number in 1831.* Günther, A. 1896.3. — *12,000 estimated in 1912.* Henshaw, H. W. Add. 1912.1. — *Number, American fossil species.* Hay, O. P. 1899.1.

"*Fish names, ancient and modern.*" Eastman, C. R. Add. 1917.2.

CLASSIFICATION

For manuals to be used in the classification of fishes from any geographic region, *see under* Fauna of the world.

For essays on the gradual development of our present system of classification, *see* Historical matter *under* Ichthyology.

Availability of embryological characters, germ layers, etc., in classification. Lankester, E. R. 1873.3, 1877.1; Ryder, J. A. 1885.7.

Taxonomic value of the brain. Burckhardt, C. R. 1897.3; Mayer, A. F. 1864.1; Wilder, B. G. Add. 1911.1. — *Proposed system, based on conditions of cavities of central nervous system.* Wilder, B. G. 1887.2.

Relation to classification, of the structure of the — reproductive system. Howes, G. B. 1891.2. — *fin-rays.* Ryder, J. A. 1887.5. — *teeth.* Linck, H. F. Add. 1789.1.

Larger and more important treatises on the systematic arrangement or relations of fishes; families, subfamilies, orders, etc. Brandt, J. F. 1865.1; Canestrini, G, 1859.3; Cope, E. D. 1871.8, 1889.5; Fitzinger, L. J. 1873.1; Gadow, H. 1898.1; Gill, T. N. 1893.2; Gregory, W. K. 1907.1; Müller, J. 1843.1,.2, 1844.2; Pascoe, F. P. 1877.1; Regan, C. T. 1909.4, 1912.13.

Miscellaneous notes on classification: relations of the different classes of vertebrates, special characters and position of the class of fishes, etc. Agassiz, J. L. 1834.3, 1850.1, 1858.1,.8; Agassiz, L. & Egerton, P. G. 1837.1; Bayer, F. 1900.1; Cope, E. D. 1868.2, 1871.8,.9, 1872.2,.4,.16, 1877.4, 1885.2,.3, 1888.2, 1889.5; Cuvier, G. L. 1814.1; Dana, J. D. 1863.1,.3; Dean, B. 1895.4; Gill, T. N. 1861.7, 1873.3,.7.

Taxonomy — *Cont'd.* 1898.1, 1912.1, Add. 1881.2; Gravenhorst, J. L. 1807.1; Hussakof, L. 1910.2; Huxley, T. H. 1876.1; Jordan, D. S. 1903.1, 1904.1; Kemna, A. 1903.1; Macleay, W. S. 1841.1; Putnam, F. W. 1872.6; Segond, L. A. 1873.1; Smitt, F. A. 1895.1; Vaillant, L. L. 1872.1.

NOMENCLATURE

Pre-Linn. nomenclature

Before the publication by Linnæus of the 10th edition of the Systema Naturæ (1758), which is the starting point for modern binomial nomenclature, numerous writers had compiled lists of local or vernacular names with attempted appropriate designations in Latin or Greek. The following titles which partly represent such attempts will be found in the Pre-Linn. *section.* Albin, E. 1735.1; Barrère, P. 1741.1; Breton, R. 1665.1; Charleton, G. 1667.1; Eber, P. & Peucer, C. 1551.1; Estienne, C. 1536.1; Fabricius, G. 1569.1; Figulus, C. 1540.1; Gesner, C. 1556.1; Gilles, P. 1535.2; Mortimer, C. 1740.1; Peucer, C. 1550.1; Quercu, L. 1539.1; Salviani, H. 1554.1; Schonevelde, S. A. 1624.1.

Forerunners of Linnæus: earlier writers who recognized modern basis of classification but who used polynomial nomenclature. Artedi, P. 1738.1; Gronovius, L. T. 1754.1; Klein, J. T. 1740.1; La Chesnaye Desbois, F. 1754.1; Ray, J. 1710.1; Willughby, F. 1686.1.

Scientific nomenclature

Original editions of the "Systema Naturæ" of Linnæus; supplemental editions of others, and notes on various Linnæan names. Donndorf, J. A. 1798.1; Gmelin, J. F. 1788.1; Goode, G. B. & Bean, T. H. 1885.4; Hopkinson, J. 1908.1; Jordan, D. S. 1886.5, 1886.6, 1891.3; Linnæus, C. 1758.1–1776.1, Pre-Linn. 1735.1; Müller, P. L. Add. 1776.1. — *Index to genera in 10th and 12th editions.* Sherborn, C. D. 1899.1.

Various nomenclatural notes: on the admission or rejection of certain names, status of names of Oken, Osbeck, Shaw, Swainson, Walbaum, et al., etc. Fox, W. J. 1900.1; Gill, T. N. 1861.7, 1897.2, 1903.6,.7,.10; Hay, O. P. 1899.3,.4,.5; Jordan, D. S. 1916.1; Jordan & Gilbert 1883.21; Swain, J. 1882.1,.2.

Proper construction of scientific names of Latin and Greek derivation. Martens, E. 1896.1; ★Miller, W. 1897.1.

Genera of fishes. (*The "Zoological Record" publishes an annual list of genera and subgenera published during the year covered.*)

General compendia (Nomenclator zoologicus, etc.) of generic names proposed in all groups, including fishes from 1758 to 1879. Agassiz, J. L. 1842.1, 1846.1, 1848.4; Marschall, A. F. 1873.1; Scudder, S. H. 1881.1, 1882.1; Sherborn, C. D. 1902.1.

"Index zoologicus," a list of generic names proposed from 1880 to 1910. Waterhouse, C. O. 1902.1–1912.1. — *Corrections and additions to this list.* Bergroth, E. E. 1904.1; Poche, F. 1907.1, 1908.1, 1909.1, 1912.1.

List of genera. Gray, J. E. 1838.2.

For the most recent contribution with the fixation of the types (1758 to 1920), see ★Jordan, D. S. Add. **1917.1.**

VERNACULAR AND COMMON NAMES

Aramaic fish names. Löw, I. 1906.1. — *Indian names for New England fishes.* Williams, R. Pre-Linn. 1643.1.

Vernacular names of local fishes in use by native populations of — Chile. Delfin, F. T. 1901.2. — *Cape Colony.* Gilchrist, J. D. 1902.2. — *Java.* Kampen, P. N. 1909.2. — *Burma.* Mason, F. 1860.1. — *Samoa.* Krämer, A. Add. 1903.1. — *Pelau Is.* Kubary, J. S. Add. 1889.1. — *Japan.* Kuroda, C. Add. 1914.1. — *Brazil.* Martius, C. F. Add. 1867.1. — *New Zealand.* Taylor, R. Add. 1870.1.

Vernacular names of European fishes, *including colloquial and local names.*

Collections of the vernacular names of European fishes in general, with their equivalents in several languages. Belloc, E. 1899.1; Henking, H. 1899.1; ★Hoek, P. P. **1904.1**; Maclagan, N. 1884.1; Martens, E. 1910.1.

Common names in use in British Isles. Cunningham, J. T. 1889.5; Koehler, J. J. 1906.1; Maclagen, N. 1884.1; Satchell, T. 1879.1.

Vernacular names of French fishes. Barbier, P. 1908.1; Belloc, E. 1899.1; Brünnich, M. T. 1768.1; Daguin, – 1904.1; Theuratte, A. D. 1898.1.

Local names of German fishes. Buxbaum, L. 1893.1; Hofer, A. 1880.1; Leonhardt, E. E. 1904.18.

Greek names, ancient, middle, and modern. Bickélas, D. 1878.1; Gill, T. N. 1905.1; Krumbacher, K. 1903.1.

Italian, Maltese and Sicilian names of native fishes, including equivalents in other languages. Barbaro, G. C. 1869.1; Faber, G. L. 1883.1; Franco, G. 1911.1; Martens, E. 1857.1; Police, G. 1912.2; Tommasini, C. 1906.1; Trapani, G. 1838.1; Smyth, W. H. Add. 1824.1; Swinburne, H. Add. 1783.1.

Portuguese vernacular names of local fishes. Furtado, F. 1886.1. — *Of fishes of Madeira Is.* Lowe, R. T. 1841.1, 1843.1.

Vernacular names in use in — Netherlands. Bemmelen, A. A. 1866.1; Hoek, P. P. 1912.2. — *Sweden.* Ekman, T. 1902.1; Lönnberg, A. J. 1894.4, 1903.2, 1906.2. — *Carniola, Austria.* Freyer, H. 1842.1. — *Iceland.* Olaffen, O. Add. 1780.1.

TECHNIQUE AND METHODS

Their use in scientific investigation.

For a related topic, *see* Collection, Preservation, and Exhibition of fishes.

Apparatus for research. *Including methods of use. Physometer, for determina-*

tion of air volume changes in air bladder. Harting, P. 1872.2, 1874.2.

Apparatus for holding fishes for vivisection: technique, etc. Pettit, A. 1904.1; Polimanti, O. 1913.3; Schoenlein, K. 1895.1.

Dynamometer for mensuration of muscular pull. Regnard, P. 1893.2,.5.

Apparatus for study of respiration. Dissard, A. 1894.1; François-Franck, C. A. 1906.1,.2; Flourens, M. J. 1862.1; Jolyet, F. & Regnard, P. 1876.1; Roques, L. 1906.1,.2; Zuntz, N. 1901.1; Hemmeter, J. C. Add. 1911.1.

Electro-cardiography in the study of heart action. Bakker, N. C. 1912.1,.2; Laulanié, – 1889.1; Eiger, M. Add. 1913.1; Hemmeter, J. C. Add. 1911.1.

Special apparatus used in the study of the electrical discharge of electrical fishes. DuBois-Reymond, E. H. 1881.1; Garten, S. 1910.1,.2; Gotch, F. 1888.1; Sachs, C. 1881.1; Biedermann, W. Add. 1895.1.

Mensuration of size; apparatus and methods. Iches, L. 1908.1; Riddell, W. 1914.1; Samter, M. 1907.1. — *Somatic coefficient, plan for expression of measurements.* Camerano, L. 1900.1, 1901.1. — *Instrument for measuring fossil fish.* Young, J. 1868.1.

Methods of study and technique. *Skeletons, technique of preparation.* Bluett, – 1830.1; Johnson, J. S. 1877.1. — *Cartilaginous skeletons.* Braun, M. G. 1894.1; Parker, T. J. 1882.2.

Ova and embryos, preparation. Collinge, W. E. 1892.1; Henneguy, L. F. 1879.1; Smith, B. G. 1914.1.

Habits and life histories, methods of study. Holder, C. F. 1908.2; Reighard, J. E. 1910.1.

Artificial circulation applied to detached heads of fishes. Kuliabko, A. 1907.1,.2, Add. 1907.1. — *Trough for exhibiting circulation in the caudal fin.* Milner, W. R. 1859.1.

Various methods. — *For dissection and study of nervous system.* Baudelot, E. 1878.1; Rawitz, B. 1909.1. — *For demonstration of neurofibrils.* Bielschowsky, — 1908.1; Fusari, R. 1901.1.

Demonstration of casts of brain. Edinger, L. 1907.1.

Physiological salt-solution for marine animals. Muskens, L. J. 1894.1.

Injection of kidney for study. Hyrtl, C. J. 1863.3. — *Injection method for comparative anatomy.* Rand, H. W. 1905.1. — *Intra-vitam staining.* Retzius, M. G. 1898.1.

Freezing point methods in study of blood. Greene, C. W. 1905.1. — *Serial sections in study of fossils.* Sollas, W. J. 1901.1, 1904.1.

Narcotization of sharks. Sulima, A. 1909.1.

Zoological dictionary, explanations of zoological terms. Ziegler, H. E. 1909.1.

Röntgen rays and radiographs, application and value. Abel, C. 1908.1; Townsend, C. H. 1906.4.

Photography. *Living fishes, chiefly in aquaria and in their natural environment.* Bade, E. 1899.8, 1901.3; Brühl, L. 1900.1; Holder, C. F. 1899.3; Köhler, W. 1904.1; Letkemann, H. V. 1902.1; Mülleger, S. 1912.1; ★Reighard, J. E. **1908.2**; ★Shufeldt, R. W. 1897.1–1911.1; Ward, F. 1911.1; ★Bryan, W. A. Add. **1911.1**; Dugmore, A. R. Add. 1902.1.

Photochronograph, for making photographs at timed intervals. Use — in study of locomotion. Anthony, R. & Chevroton, L. 1913.1; Marey, E. J. 1890.1. — *in study of respiration.* François-Franck, C. A. 1906.2, Add. 1907.1, 1914.1.

Photography with ultra-violet light. Franz, V. 1910.6. — *Photography of developmental series.* Kupffer, C. W. 1876.2; Reighard, J. E. 1900.3.

TEMPERATURE (*EFFECTS ON FISHES*)

Reactions of fishes to variations in temperature. Dupony, – 1894.1; Knauthe, K. 1891.4; Loeb, J. & Wasteneys, H. 1912.1; Michael, E. Add. 1907.1; Wells, M. M. Add. 1914.1.

Effects of temperature on development of ova. Dannevig, H. C. 1894.1; Dannevig, H. C. & Fulton, T. 1895.1; Drouin de Bouville, R. 1908.2; Grimm, O. 1904.2; Hein, W. 1911.2; Meyer, H. A. 1879.2; Reibisch, J. 1902.1; Williamson, H. C. 1910.1,.3, 1911.1. — *Influence on embryonic circulation.* Millet, C. 1864.1.

Effects of temperature upon iris. Brown-Séquard, C. E. 1859.1; Müller, H. 1861.1. — *On vitality of fishes.* Davy, J. 1862.1. — *On pigmentation.* Frisch, K. 1911.3. — *Relations to number of vertebræ.* Jordan, D. S. 1892.2, 1893.2, 1894.3. —*Relation to the number of finrays in Pleuronectidæ (reduction in warmer climates).* Cox, P. Add. 1903.1.

Cold, effects. Dönhoff, –. 1872.1; Heath, N. 1883.1; Marès, H. 1850.1, Add. 1850.1; Marion, A. F. 1894.2; Vidal, J. L. 1870.1, 1871.1; Beal, J. Pre-Linn. 1666.1.

Influence on pigmentation and respiration, Apogon. Polimanti, O. 1912.2.

Cold causing mortality. Bouney, T. G. 1891.1; Jennings, F. M. 1841.1. — *Destruction on Florida coast.* Packard, A. S. 1870.1; Wilcox, J. 1887.1. — *At Bermuda, 1901.* Verrill, A. E. 1901.1. — *Eels.* Thompson, W. 1841.3.

Extremes of temperature *in which fishes can live.* Maurel, – & Lagriffe, – 1899.1,.2, Add. 1899.1; Carter, A. W. Add. 1887.1.

Basic or lowest temperature. Dutrochet, R. J. 1840.1,.2; Pictet, R. 1893.1; Regnard, P. 1895.1.

Maximum or highest temperature. Bert, P. 1867.4; Davy, J. 1862.1; Davenport, C. & Castle, W. 1895.1; Frenzel, J. 1885.1; Knauthe, K. 1895.3; Lefebre, A. 1872.1; Vernon, H. M. 1899.1, 1900.1.

Temp. Effects — *Cont'd.*

Heat, influences. Day, F. 1885.2; Fatio, V. 1899.2; Frenzel, J. 1896.1; Goette, A. 1909.1. — *Influence on pigmentation.* Murisier, P. 1912.1.

Shad killed by heat in Connecticut R. Green, S. 1869.1. — *Volcanic heating of water effecting migrations.* Krebs, W. 1912.1.

Resuscitation of frozen fishes *after animation had been suspended.*

Reports of occurrences, experiments, etc. Aitch, W. 1875.1; Clarke, R. 1854.1; Dougherty, W. E. 1875.1; Hubbard, O. P. 1850.1; Kirtland, J. P. 1851.1; Knauthe, K. 1887.1; Lathrop, S. P. 1852.1; Mowry, A. H. 1875.1; Peirce, M. P. 1884.1; ★Pictet, R. 1893.1; Smiley, C. W. 1884.12; Welsher, H. W. 1879.1; Wigg, G. 1882.1; Zur Mühlen, M. 1911.14; Anon. 632; Athenæus, N. Pre-Linn. 1680.1.

Resuscitation after hibernation, Umbra. Abbott, C. C. 1874.3: *Dallia.* Turner, L. M. 1886.1 (*p.* 101).

Relations between climate and fisheries. (*Meteorological conditions*). *Miscellaneous.* Eidsvaag, E. 1909.1; Marion, A. F. 1894.7; Muirhead, G. 1903.1.

Climatic influences on fisheries of — Sardine. Blavier, A. 1882.1; Odin, A. 1896.1. —*Herring.* Buckland, F. T., Walpole, S. & Young, A. 1878.1; Krebs, W. 1911.1; Otterstrøm, A. N. 1910.1. — *Anchovy.* Fowler, G. H. 1889.1.

Effects of Gulf stream on European sea fisheries. Johnstone, J. 1910.3.

TEMPERATURE OF FISHES (*OR CALOR ANIMALIS*)

In fishes, as in other "cold-blooded animals," the body temperature is generally considered to be variable and approximately that of the surrounding medium.

Davy observed a deep-muscle temperature in the bonito (*Thynnus*) nearly 10° C. higher than the water.

Subsequently, Kidder demonstrated by special thermometers that readings as usually taken in the œsophagus or rectum are untrustworthy and that those from deeper centers such as heart, liver or stomach show an excess of several (4 or 5) degrees F. above the water temperature.

More recently Simpson has found that small examples show practically no excess while larger examples show a temperature averaging a half degree Centigrade higher than the water.

Observations, actual records of temperature, and methods of investigation. ★Kidder, J. H. 1880.1; King, R. 1836.1; Portier, P. 1903.1, 1908.1; Regnard, P. 1895.3; ★Simpson, S. 1908.1,.2. — *Thynnus considered a warm-blooded fish.* Davy, J. 1835.1, Add. 1835.2.

Miscellaneous notes, reviews, etc. Delaroche, F. E. 1807.1; Fibich, S. 1904.1; Gill, T. N. 1881.3; Grieg, J. A. 1909.1; Harting, P. 1880.1; Kidder, J. A. 1880.1; Anon. 106, 586. — *Production of heat.* Dubois, R. 1899.3.

TERATOLOGY

See also under related subjects *such as* Hermaphroditism, *and* Regeneration. *For* Ambicoloration or unicoloration in flat-fishes, *see under* Pleuronectidæ. For all *other* Abnormalities in coloration, *see under* Coloration.

General treatises. *For a model treatise with discussions of causation, development, etc., and with a résumé of the literature, see* ★Gemmill, J. F. **1912.1.**

Other general treatises. Heusner, - 1824.1; ★Otto, A. W. 1841.1; Rauber, A. 1877.1, 1879.1; ★Schwalbe, E. **1906.1;** Taruffi, C. 1894.1; Geoffroy-Saint-Hilaire, I. Add. 1832.1; Rayer, P. F. Add. 1843.1. — *Earliest general work.* Aldrovandi, U. Pre-Linn. 1642.1.

Experimental results. *Artificial production of monsters by use of saline and sugar solutions and other media.* Bataillon, E. 1901.1,.2; Lereboullet, D. A. 1861.2, 1862.1,.3; Supino, F. 1896.1; Tornier, G. 1908.1, 1911.1; Dareste, C. Add. 1861.1; Loeb, J. Add. 1915.1. — *urea, butyric acid, sodium glycocholate, etc.* Werber, E. I. 1915.1,.2. — *See also* ★E. I. Werber *in* Journ. Exper. Zool., 1916, *vol.* 21, *pp.* 485–573; *and* 1917, *vol.* 24, *pp.* 409–436.

See also below under Cyclopia, *for experimental production of this abnormality.*

Miscellaneous papers. Barras de Aragón, F. 1905.1; Couch, J. 1868.1; Keith, A. 1909.1; Marchand, E. 1901.1; Nusbaum, J. 1907.3; Rabaud, E. 1901.1, .2; Richard, J. 1912.1; Traquair, R. H. 1900.3; Williamson, H. C. 1911.2. — *Collection in Royal College of Surgeons, London; catalogue.* Lowne, B. T. 1893.1. — *Dwarf races of fishes.* Klunzinger, C. B. 1900.1.

Various abnormalities. *Abnormal dentition in — Raja.* Day, F. 1880.2. — *Rhinoptera.* Woodward, A. S. Add. 1888.1. — *Teeth replaced by gills in Acanthias.* Grosser, O. & Przibam, H. 1906.1.

Skin and Scales. — *Hypertrophy of skin.* Arnold, J. P. 1911.16. —*Egg-cells in skin, Macropodus.* Zschiesche, A. 1910.1. —*Abnormal scales in pilchard.* Bateson, W. 1894.3. — *in flounders.* Herdman, W. A., Scott, A. & Johnstone, J. 1905.1.

Supernumerary barbels in Siluridæ. Eigenmann, C. H. & Cox, U. O. 1900.1; Roth, W. 1905.2.

Abnormalities of gill-clefts in — Squalus. Ekman, G. 1910.1. — *Myxine and Petromyzon.* Howes, G. B. 1893.1. — *Petromyzon lacking branchial orifices.* Blanc, H. 1913.1. — *Opercular gills, abnormal in Polypterus.* Boulenger, G. A. 1899.8. — *Operculum perck.* Flintoff, R. J. 1896.1.

Two ova in one egg case in sharks. Joseph, H. 1906.1; Vayssière, A. 1909.1.

Abnormalities with type of anomaly not indicated. — *Anguilla.* Ninni, E. 1910.1. — *Barbus.* S., G. 1880.1. — *Carassius.* Charvet, P. A. 1826.1. — *Carp.* Böckh, G. 1863.1; Tiedemann, D. F. 1819.1; Ballot, - Add. 1837.1. — *Salmonidæ.*

Fabani, C. 1897.1; Grieg, J. A. 1911.2; Anon. 570.

ABNORMALITIES OF THE EYE

Various sorts of anomalies. Girdwoyń, M. 1880.1; Makarius, S. 1898.1. —*Abnormal eye-muscle in Carcharias.* Allis, E. P. 1899.1. —*Eyeless spm. of Cyprinus.* Baer, K. E. 1862.1. —*Doubling of crystalline lens.* Hilgendorf, F. M. 1903.1. —*Develop. of lens without other eye-parts.* Mencl., E. 1903.1. —*Supernumerary eyes.* Gemmill, J. F. 1906.1. —*Three-eyed dab.* Meek, A. 1910.1. —*Three-eyed Whiting.* Rose, C. W. 1863.1. —*One-eyed cod.* Sandeman, G. 1893.1. —*One-eyed trout.* Yung, E. J. 1901.1. —*Atrophy in Raja.* Smallwood, W. M. 1908.1.

For anomalies of the eye in flat-fishes, such as arrested migration during metamorphosis, etc., see under Pleuronectidæ.

Cyclopia. *A single, median-eyed condition. Occurrence.* —*in Teleostei.* Gemmill, J. F. 1900.1, 1906.2; Chidester, F. E. Add. 1914.1. —*in Myliobates noctula.* Paolucci, L. 1874.1.

Artificial or experimental production of cyclopia by various solutions. Lereboullet, A. 1861.2; Lewis, W. H. 1909.1; McClendon, J. F. 1910.1, 1912.1; Spemann, H. 1904.1; ★Stockard, C. R. 1907.1, 1908.2, 1909.1,.2, 1910.1; Tornier, G. 1908.1, 1911.1.

ABNORMALITIES OF FINS

Gen. acct., fin anomalies. Freund, L. 1907.1.

Carp with all fins greatly elongated. Bean, B. A. 1909.2.

Misc. papers. —*Origin.* Buschkiel, A. 1907.1. —*Paired anal and caudal fins.* Cori, C. J. 1896.1. —*Anomalies in Pleuronectidæ.* Duncker, G. 1900.2. —*Supplementary fin in Tinca.* Yung, E. Add. 1914.1.

Anal fin. *Anomalies in* —*Sebastes.* Jaquet, M. 1906.1. —*Plaice.* Johnstone, J. 1904.2. —*Proteracanthus.* Pellegrin, J. 1899.3. —*Goldfishes.* Watase, S. 1887.1, 1894.1.

Caudal fin. —*Larval Petromyzon with three caudal fins.* Barfurth, D. 1899.1. —*Caudal absent in carp.* Fiebiger, J. 1907.1; Nusbaum, J. 1907.3; Tarnaniĭ, I. K. 1911.1. —*Caudal and peduncle lacking, Esox.* Hofer, B. 1901.3. —*Anomalies in Silurus and Motella.* Jaquet, M. 1899.1, 1907.2. —*Precaudal fin frill in plaice.* McIntosh, W. C. 1908.2. —*Syngnathus with duplicated tail.* Malm, A. W. 1862.1. —*Pleuronectes with secondary caudal.* Woodward, H. 1908.1.

So-called "tailless trout" of Lochnamoarachan, Islay, Scotland, Salmo islayensis or S. fario. Peach, C. W. 1871.1; Thomson, J. 1873.1; Traquair, R. H. 1872.1, 1882.2, 1892.5.

Dorsal fin. *Accessory fins in* —*Acanthias.* Grosser, O. & Przibram, H. 1906.1. —*Salmo.* Seligmann, C. G. 1898.1.

Pectoral fin. *Abnormality, resembling digital structure, in Protopterus.* Albrecht, P. 1886.3; Blanchard, R. 1894.1; Boulenger, G. A. 1891.4; Hopley, C. C. 1891.1. —*Duplicity in Lepidosiren.* Brindley, H. H. 1900.1; Goeldi, E. A. 1898.1.

Abnormalities corresponding to types of limb structure. Ercolani, G. B. 1881.1.

Type of abnormality in rays in which the pectorals are not adherent to the head. ★Anisits, J. D. 1912.2; Bureau, L. 1890.1; Day, F. 1880.2; Filippi, F. 1852.1; Fleming, J. 1841.1; Gervais, F. L. 1864.1; Hill, J. P. 1895.1; Johnstone, J. 1906.2; Paolucci, L. 1874.1; Pellegrin, J. 1900.8; Rafinesque, C. S. 1810.2; Reinhardt, J. C. 1825.1; Richardson, J. 1859.1; Traquair, R. H. 1892.4; Vaillant, L. L. 1908.2; Williamson, H. C. 1911.2. —*Described as Propterygia, n. g.* Otto, A. W. 1821.2, 1822.1. —*Propterygia shown to be teratological.* ★Lütken, C. F. 1880.2; Gill, T. N. 1896.13. —*First known acct. and fig.* Gesner, C. Pre-Linn. 1556.1.

Pectorals absent in —*flounder.* Gill, T. N. 1881.3. —*Silurus.* Jaquet, M. 1897.3.

Supernumerary pectorals in —*Salmo irideus.* Mazzarelli, G. F. 1905.2. —*Raja.* Deslongchamps, J. A. 1853.1; Rennie, J. 1906.1. —*Presence in Symbranchus, normally absent.* Derjugin, K. M. 1912.1.

Ventral or pelvic fins. *Anomalies in* —*Leuciscus dobula.* Martens, E. 1859.1. —*Pagellus.* Mazza, F. 1890.1. —*Elongation in Tinca.* Billard, G. 1912.1. —*Male dogfish, with abnormal external genital apparatus.* Mudge, G. P. 1899.1.

Supernumerary pelvics (Pygomely). Anthony, R. & Salmon, J. 1901.1. —*in Phoxinus.* Derjugin, K. M. 1912.1. —*in Glanis.* Varpakhovskiĭ, N. A. 1888.2.

Ventrals absent in —*Abramis.* Brindley, H. H. 1891.1. —*Ameiurus.* Eigenmann, C. H. & Cox, U. O. 1900.1.

VISCERAL ABNORMALITIES

Abdominal abnormalities. —*Misplacement of abdominal cavity.* Raffaele, F. 1889.2. —*Gastrodidymus, double-formation of belly.* Rauber, A. 1879.2.

Circulatory system. —*Deformations.* Künstler, J. & Gruvel, A. 1899.1. —*Embryos without circulation.* Loeb, J. 1893.1.

Digestive system. —*Perch without pyloric cœca.* Forbes, S. A. 1885.1. —*Dogfish with everted stomach.* Mudge, G. P. 1905.1, 1906.1. —*Abnormal spiral valve, Raja.* Parker, T. J. 1885.1. —*Branched cœca, Centrolophus.* Riggio, G. 1894.2. —*Prolapsus recti.* Pégot, G. 1900.1. —*Sparus with a supplementary anus.* Williamson, H. C. 1911.4. —*Abnormal intestine, carp.* Freund, L. Add. 1914.1.

Reproductive organs. —*Three lobed ovary, Acipenser.* Grimm, O. 1906.2. —*Arrested development in gonad of Conger.* Hefford, A. E. 1907.1. —*Hypertrophied ovaries in Cobitis.* Lunel, G. 1880.1. —*Oviduct, male skate.* Matthews, J. D.

Teratology — *Cont'd.* 1885.1. — *Abnormalities in Scyllium.* Borcéa, J. 1904.8.

Nervous system. — *Defective brain, Torpedo.* Coggi, A. 1891.1. — *Auditory nerve, anomaly.* Cortese, F. 1868.1. — *Suppl. lateral line, Acipenser.* Jaquet, M. 1899.2. — *Abnormal cerebellum, Alopias.* Léger, M. 1887.1. — *Pelvic plexus, Acanthias.* Punnett, R. C. 1901.1.

AXIAL ABNORMALITIES

Skull abnormalities, type not indicated. — *Labrax.* Ayres, W. O. 1849.4. — *General.* Freund, L. 1907.1. — *Esox.* Poppius, B. 1911.1. — *Gadus.* Wyman, J. 1851.2.

Abnormalities in snout and jaws. *Malformed jaws in* — *Esox.* Brofeldt, P. 1912.1; Hopewell-Smith, A. 1908.1. — *Trigla.* Johnston, J. 1906.2. — *Produced jaws in Salmo.* Yung, E. J. 1901.1.

Anomalies of the snout in — *Acipenser and Sargus.* Jaquet, M. 1897.1, 1911.1. — *Carp.* Erhard, G. Pre-Linn. 1748.1; Hamberger, G. E. Pre-Linn. 1748.1.

Buccal occlusion or absence of mouth. *Associated with abnormalities of jaws, etc.*

Examples in the carp. Fehlmann, J. W. 1912.1; Hofer, B. 1904.2,.3; Schiemenz, P. 1897.1; Steindachner, F. 1863.7; Wundsch, H. H. 1913.1; Geoffroy-Saint-Hilaire, I. Add. 1832.1.

Examples in — *Abramis.* Garstang, W. 1897.2; Münch, - 1911.1. — *Sclerognathus.* Lawrence, G. W. 1875.1. — *Chondrostoma.* Pellegrin, J. 1908.14. — *Catostomus.* Leidy, J. Add. 1875.1.

Shortening and curvature of snout; "Mopskopf." *Also called Pug-head or Bulldog-head, Tête du chien, etc.*

Examples in various fishes. Lönnberg, A. J. 1892.2; Ninni, E. 1903.2; Putnam, F. W. 1866.3; Stach, J. 1906.1. — *Heredity of "Mopskopfigkeit."* Knauthe, K. 1893.3. — *Artificially induced.* Tornier, G. 1908.1, 1911.1.

Examples in the carp. (*Cyprinus carpio*). Böckh, G. 1863.1; Donnadieu, A. L. 1870.1; Heuscher, J. 1911.1; Jaquet, M. 1902.1; Steindachner, F. 1863.7; Aldrovandi, U. Pre-Linn. 1642.1.

In cod (*Gadus morrhua*). Cobbold, T. S. 1858.1; Federley, H. 1908.1; Patterson, A. H. 1898.1; Willumsen, P. J. 1901.1.

In salmon and trout. Buckland, F. T. 1877.2; Carlet, G. 1879.2; Krauss, F. 1886.1; Lidth de Jeude, T. W. 1885.1; Cornay, J. E. Add. 1847.1.

Examples in various teleosts. — *Mugil.* Canestrini, R. 1886.1. — *Labrax.* Fasciolo, A. 1904.1. — *Esox.* Hofer, B. 1901.3. — *Abramis.* Leonhardt, E. 1906.13. — *Cottus.* Nyström, E. 1889.1. — *Lumpenus.* Pappenheim, P. 1907.3. — *Trigla.* Patterson, A. H. 1897.1. — *Perca.* Pellegrin, J. 1908.16,.17. — *Atherina.* Seabra, A. F. 1907.1. — *Roccus.* Sutton, A. C. 1913.1. — *Micropterus.* Herrick, F. H. Add. 1885.1.

Vertebral column. *General anomalies.* Deslongchamps, J. 1861.1; Hyrtl, C. J. 1849.4, 1862.1; Pellegrin, J. 1902.4; Wieber, J. D. 1903.1; Bruch, C. Add. 1862.2. — *Palistrophy (Coalesced vertebræ) in Cobitis.* Giard, A. 1900.3.

Vertebral and notochordal reduplications. Gemmill, J. F. 1906.1. — *Ling with five backbones.* Cornish, T. Add. 1884.1.

Spinal curvature. Misc. and gen. Holt, E. W. 1890.1; Howes, G. B. 1894.1; Keller, O. 1911.1; Koch, M. 1912.2; Williamson, H. C. 1910.1. — *In Chondrostoma.* Surbeck, G. 1913.3. — *Examples in Gadidæ.* Smith, John A. 1867.10; Storrow, B. 1910.1; Williamson, H. C. 1911.3. — *in Salmonidæ.* Cobbold, T. S. 1855.1; Ritchie, J. 1908.2; Surbeck, G. 1913.4; Vávra, V. 1906.1. — *Trigla.* Kyle, H. M. 1900.4.

DOUBLE MONSTROSITIES

So-called double or twin embryos occurring usually among the fry, recorded especially among salmon and trout. Including also "duplicities" in sense of Werber.

General treatises. *Anatomy, development, theories of causation, etc.* Blanc, L. 1896.1; ★Gemmill, J. F. 1901.1, 1903.1, 1912.1; Klaussner, F. 1890.1; Kopsch, F. 1899.1; ★Lanzi, L. **1911.1**; ★Meckel, J. F. 1815.1; Panum, P. L. 1878.1; ★Schmitt, F. **1901.1,** 1902.1; Valentin, G. G. 1851.1.

For a recent experimental analysis, with causation viewed as a developmental arrest, see ★Stockard, C. R. *in* Am. Journ. of Anat., 1921, *vol.* 28, 115–266.

Minor papers, records of occurrence, etc. *Chiefly Salmonidæ.* Barbieri, C. 1906.2,.3; Bataillon, E. 1900.3; Bean, B. A. 1889.3; Bugnion, E. 1880.1; Coolidge, A. 1869.1; Coste, P. 1855.1; Deslongchamps, J. A. 1862.1; Garman, S. & Denton, S. F. 1886.1; Geoffroy-Saint-Hilaire, I. 1855.1; Girdwoyń, M. 1880.1; Grieg, J. A. 1900.2; Jacobi, S. L. 1765.1; Knoch, J. 1873.1; Kaestner, S. 1898.1; ★Moser, F. 1907.1; Oellacher, J. 1874.1, .2; Quatrefages, J. L. 1855.1,.2, 1874.1, 1888.1; Rauber, A. 1880.1; Salm-Horstmar, W. F. 1861.1; Serres, P. M. 1855.2; Windle, B. C. 1889.1, 1895.1; Chidester, F. E. Add. 1914.1; Putnam, F. W. Add. 1870.1.

Adult double monsters. — *in Felichthys.* Churchill, H. 1834.1. — *in Salmo.* Secques, F. 1895.1. — *Two-headed adult salmon.* Yarrell, W. 1836.1.

Double embryos of sharks, chiefly double-headed examples. Baster, J. 1762.2; Bean, B. A. 1889.3; Dohrn, A. 1902.1; Gadeau de Kerville, H. 1892.1; Levison, F. 1878.1; Willard, W. A. 1915.1. — *First known reference to double sharks.* Aldrovandi, U. Pre-Linn. 1642.1.

Double monstrosities in — *Petromyzon.* Bataillon, E. 1900.2. — *Girardinus.* Emeljanenko, P. E. 1907.4. — *Esox.* ★Lereboullet, A. 1855.1. — *Perca.* Baer,

K. E. Add. 1845.1. —*Zoarces.* Rathke, M. Add. 1833.1.

THEOLOGY AND FISHES

For the fish in mythology and folk-lore *see* Mythology and Symbolism.

For a valuable recent work in English, with chapters including discussions of the Christian fish symbol, the Tobias fish, and "Jonah and the whale," see Wm. Radcliffe, "Fishing from the earliest times." London. 1921. 478 p. ills.

The fish in Brahmanism and Buddhism. Carus, P. 1911.2. —*Zoology of the Talmud.* Lewysohn, L. 1858.1. —*Sacred fish in India.* Crooke, W. Add. 1906.1.

Christian fish symbol. "A fish frequently figures on the tombs of the early Christians in the catacombs at Rome: sometimes it bears on its back a bowl with wine and wafers of bread. Many tombs contain small fish of wood or ivory. Such fish served, we are told, as emblems and acrostics, pointing out to his co-religionists the burial place of a Christian without betraying the fact to the persecutors." Radcliffe.

For the latest and best monograph on the Christian fish symbol, see F. J. Dölger "Das Fischsymbol in frühchristlicher Zeit," Freiburg, 1910. *A summary of this appears in the* Archiv für Religionswissenschaft, 1912, vol. 15, p. 297.

Theories of origin of Christian fish symbol. Achelis, H. 1888.1; Garbe, R. 1914.1; Morey, C. R. 1910.1; Pischel, R. 1905.1; Polidori, L. 1841.1; ★Scheftelowitz, I. I. 1911.1.

The fish in religious festivals. —"*Paul und Peter, in Mecklenburg. Fischerfest am 29 Juni.*" Karrig, Add. 1912.1. —*Christfische.* "*Alte Sitte in Nürnberg.*" Anon. 660.

Tobias fish. *Sand-launce (Ammodytes) of the Tigris, of which Tobias burned the heart and liver to drive away the demon Asmodeus.* Bening, – Add. 1780.1. — Pre-Linn. *refs.* Bochart, S. 1619.1; Hardt, H. 1719.1; Seelen, E. G. 1708.1.

Fishes of the Bible

Accounts of the various fishes mentioned in the Holy Scriptures. Loreta, G. 1901.1; Thunberg, C. P. 1827.1; Tristram, H. B. 1867.2; ★Wood, J. G. 1868.1, 1869.1, Add. 1876.1; Harris, T. M. Add. 1824.1; Hart, H. C. Add. 1888.1.

Pre-Linn. *refs. to Biblical fishes.* Bochart, S. 1619.1; C., A. 1756.1; Clodius, D. 1675.1; Franz, W. 1643.1; Frey, H. H. 1594.1; Gardiner, S. 1606.1; Richter, J. G. 1754.1; ★Scheuchzer, J. J. 1731.1.

Locusts of the plague considered to be flying fish. Brodd, A. 1705.1.

Fishes of the Deluge: early belief that fishes in the rocks (i. e. fossils) were remains of the flood. Pre-Linn. *refs.* Scheuchzer, J. J. 1731.1; Torrubia, P. F. 1754.1; Vallisnieri, A. 1721.1.

Creation of Fishes. (*Fifth day of Creation.*) —*Refs. in* Pre-Linn. *section.* Albertinus, A. 1613.1; Ambrose, 1472.1; Basilius Magnus 1551.1; Du Bartas, G. 1608.1; Eustathius, – 1629.1; Isidore of Seville, 1472.1; Kozack, J. S. 1662.1; Moor, B. 1716.1; Pisides, G. 1614.1; Scheuchzer, J. J. 1731.1.

Jonah and the Whale. *Early views showing belief that this animal was in reality a shark.* Gunner, J. E. Add. 1768.1; Holm, I. W. Add. 1776.1. —Pre-Linn. *refs.* Arctander, S. 1698.1; Beermann, S. 1719.1; Bochart, S. 1619.1; Colbiörnsen, F. 1744.1; Engelbrecht, J. 1702.1; Frey, H. 1594.1; Hardt, H 1718.1; Kirchmaier, — 1705.1; Lipenius, M. M. 1678.1; Major, J. H. 1685.1; Paullini, C. F. 1677.1; Pechlin, J. N. 1697.1; Pfeiffer, S. A. 1692.1; Scheuchzer, J. J. 1731.1; Siegesbeck, J. G. 1725.1; Willisch, C. G. 1721.1.

For an excellent monograph on the Jonah myth, see Hans Schmidt, "Jona: Eine Untersuchung zur vergleichenden Religionsgeschichte." Göttingen, 1907. ills.

THYMUS GLANDS

Glands in the pharyngeal region arising from the epithelial entoderm of the second to sixth branchial clefts.

For related structures, *see* Thyroid Gland *and* Post-branchial Body.

Anatomy and morphology. General treatises. ★Hammar, J. A. **1910.1**; Hansen, C. P. 1832.1.

Anatomical researches on the thymus in —Ganoids. Ankarsvärd, G. & Hammar, J. A. 1913.1. —*Ammocœtes.* Castellaneta, V. 1913.1. —*Elasmobranchs.* ★Hammar, J. A. **1911.1**. —*Fishes in general.* Kner, R. 1864.3. —*Teleosts.* Maurer, F. 1886.1; Stannius, F. H. 1850.1. —*Ameiurus.* Mackenzie, T. 1884.1.

Development, general accounts. ★Beard, J. 1895.1; Meuron, – 1886.1.

In Elasmobranchii. —*Raia.* Beard, J. 1902.5. —*Spinax.* Fritsche, E. 1909.1. —*Selachii.* 1910.1; Maximow, A. 1912.1. —*Element of spiracle in thymus of Selachii.* Antipa, G. 1892.1; Beard, J. 1900.2.

Development in various fishes. —*Lepidosiren.* Bryce, T. H. 1906.1. —*Teleosts.* Nusbaum, J. & Prymak, T. 1901.1; Prymak, T. 1901.1–1903.1. —*Petromyzon.* Schaffer, J. 1894.1. —*Acipenser.* Sokolov, A. J. 1912.1.

Histology of the thymus. ★Hammar, J. A. (*Teleosts*) **1908.1**; Prymak, T. 1902.1; Schaffer, J. 1893.1.

Physiology, function of thymus. Basch, – 1906.1; Beard, J. 1895.1, 1900.1. —*Relation to blood development.* Schaffer, J. 1893.1.

THYROID GLAND

A ductless gland found in the pharyngeal region, arising as an unpaired pocket in the floor of the pharynx.

For related bodies, *see* Thymus Gland *and* Post-branchial Body.

For carcinoma of thyroid in brook-trout, *see under* Pathology.

Thyroid — *Cont'd.*

Anatomy and morphology. General treatises. — Vertebrates especially Selachii. ★Guiard, J. **1896.1.** — *Vertebrates.* Thompson, F. D. 1910.1.

Miscellaneous papers. Herrmann, G. & Verdun, P. 1900.1; Julin, C. 1887.5. — *Structure, distribution, and variation.* Gudernatsch, J. F. Add. 1909.1.

Anatomy in Cyclostomata. — Petromyzon. Reese, A. M. 1902.1. — *Ammocœtes.* Schrön, O. 1865.1. — *Myxine.* Schaffer, J. 1906.1.

In Elasmobranchii. ★Ferguson, J. S. **1911.1**; Goodey, T. 1910.2; Lombard, G. D. 1909.1; Robin, C. P. 1847.3.

Ganoidei. Hyrtl, C. J. 1852.1.

Teleostei. ★Gudernatsch, J. F. **1911.2**; Mackenzie, T. (*Ameiurus*) 1884.1; Maurer, F. 1886.1.

Development. General accounts. Meuron, - 1886.1; Müller, W. Add. 1871.1. — *Amphioxus, Cyclostomes, and Pisces.* ★Dohrn, F. A. **1882.2** (vii, xi, xii).

In Cyclostomata. — Ammocœtes. Marine, D. 1913.1. — *Petromyzon.* Reese, A. M. 1902.1. —*Bdellostoma.* Stockard, C. R. 1906.3.

Histology. Ammocœtes. Renaut, J. & Policard, A. 1905.1.

Physiological and chemical papers. — Iodine content of thyroid. Cameron, A. T. 1913.1. — *Relations between normal and pathological thyroids.* Gudernatsch, J. F. 1911.1. —*Effects of thyroid feeding in young salmon.* Giacomini, E. Add. 1914.2.

URINOGENITAL SYSTEM (*OF FISHES*)

Comprising the structure of the excretory, nephridial or renal organs, and the generative or reproductive organs of fishes. Since in fishes, as in the other groups of vertebrates, there exists an intimate developmental and topographical relationship between the excretory and reproductive organs, the ducts of the former serving to carry the products (eggs or sperms) of the latter, the two systems have in the literature generally been considered together and are so treated here.

Few morphological systems have been the subject of greater controversy than the present and, as far as possible, the present state of these controversies is indicated below.

The most valuable comprehensive general treatise (in German) on the development and structure of the urinogenital system in vertebrates, including all groups of fishes and containing an extensive bibliography, is the series cited under ★Felix, W. & Bühler, A. **1906.1,.2.**

Similar comprehensive general treatises in German are those of ★Rückert, J. Add. **1892.1**; *brought up to 1904 by* ★Felix, W. Add. **1904.1.**

The most recent and valuable summary in English is the account in the " Text-book of Embryology " *by* ★Prof. J. G. Kerr. Vol. II, (Vertebrata), London, 1919, 591 p.

Other readable general summaries in English may be found in Bridge, T. W. 1904.1, *and in* Kingsley, J. S. 1912.1.

Miscellanea

Older but still interesting and historically valuable accounts of the excretory organs, in English, are cited under Balfour, F. M. 1876.2, 1882.1; *and* Sedgwick, A. 1881.1.

Various general works in German, treating of the excretory or urinogenital organs in nearly all groups of fishes are Fürbringer, M. 1878.2; ★Hoffmann, C. K. 1886.1; Hyrtl, C. J. 1850.1; Solger, B. F. 1882.1.

Similar older general works in French on the reproductive organs are Martin-Saint-Ange, G. J. 1856.1; Treviranus, G. R. 1826.1,.2; Vogt, C. C. & Pappenheim, S. 1859.1.

Various unclassified, relatively unimportant, or older papers on the excretory organs. Cappello, O. 1845.1; Crevatin, F. 1904.1; Huefner, C. G. 1866.1; Müller, J. 1845.3; Rathke, M. H. 1837.2; Burnett, W. I. Add. 1854.2.

External urinogenital appendages

In both males and females of the Siluroid Plotosus, behind the urinogenital papilla, there is a peculiar arborescent vascular and glandular appendage of unknown function. Brock, J. 1888.1; Hirota, S. 1895.1.

In both sexes of the Syngnathid, Gasterotokeus, (better developed in females) there is a protuberance covered with papillæ (tastkissen) just before the anal fin. Brock, J. 1887.1.

In both sexes in various species of Blennius, peculiar complicated urinogenital appendages occur. ★Guitel, F. 1893.1.

The structures just mentioned are presumably not to be confounded with the male intromittent organs of certain viviparous fishes.

For the copulatory organs (Myxopterygia) of male Elasmobranchs, see below Viviparity *under* Reproduction.

For the intromittent organs of various viviparous Teleosts, see under such families as Pœciliidæ *below* Ovarian gestation of Teleosts *likewise under* Viviparity.

EXCRETORY ORGANS

The whole series of vertebrate nephridial tubes was termed " archinephros " by Lankester (1877.1). Sedgwick (1881.1, p. 458) held the view that the pronephros, mesonephros and metanephros (Lankester's terms) are merely successive parts of a single, elongated ancestral excretory organ which possessed a duct and segmentally arranged nephridial tubules.

These views were further substantiated by Price's work on *Bdellostoma* (Price, G. C. 1897.1) who conceived of the entire embryonic kidney as a " holonephros " from which the pronephros and mesonephros are derived.

These views of homologies are now generally accepted.

A related view is that of Audigé (1910.1, p. 614) who conceives of the Teleostean kidney as a " mononephros " in which the three regions, when they exist, are synchronous in development.

Pronephros

Called also " Vorniere " and " head-kidney." As considered by Balfour (1882.1) the pronephros is a purely larval organ ordinarily functioning only in larval vertebrates. For possible exceptions to this statement among Teleosts, *see* below *under* "Persistence of pronephros."

As pointed out by Sedgwick (1881.1) the pronephros is greatly reduced or non-functional in meroblastic vertebrates.

Origin of pronephric duct. Various conclusions have been held concerning the origin of the pronephric (called also archinephric and segmental) duct. In Elasmobranchs, this was described by van Wijhe, Beard, Rückert, and Gregory, as arising by the splitting off of a longitudinal ridge-like projection from the ectoderm. More recently Rabl and Bates have maintained that the anlage of the duct is a direct outgrowth of the pronephros and therefore mesodermal in origin.

Discussions of the origin of the pronephric duct in Elasmobranchs. ★Bates, G. A. 1914.1; Beard, J. 1888.5; Gregory, E. R. 1897.1; Haddon, A. C. 1886.1; ★Rabl, C. 1896.1; ★Rückert, J. 1888.2, 1889.2; Wijhe, J. W. 1886.1, 1888.1,.2, 1898.1.

Similar conflicting views have been held as to the origin of the pronephric duct in Teleosts. Brook, G. 1888.1; Oellacher, J. 1872.1,.2.

Origin of Müllerian duct. In selachians as first discovered by Semper (Semper, C. G. 1874.1) and also independently observed by Balfour (Balfour, F. M. 1876.2, p. 20), the archinephric duct by a longitudinal splitting from before backward forms a dorsal duct (Wolffian, Leydig's or mesonephric duct) and a ventral duct to which Balfour limited the term, Müllerian duct. In males, the splitting is more partial and in general only parts of the Müllerian duct persist.

It is now generally accepted that, although differing in development, the Müllerian duct in all higher groups of vertebrates becomes the functional oviduct and is generally considered homologous throughout the vertebrate series. In the Teleost, however, the oviducts seem to be mainly ovarian in origin.

Balfour, however, believed that in the Teleosts also, the oviducts are modified Müllerian ducts and this view has at times gained some acceptance. This matter is further discussed below.

For full discussions of the origin of the Müllerian duct in Selachians, see Holzbach, E. 1909.1; Rabl, C. 1896.1; Rückert, J. 1888.2; Wijhe, J. W. 1888.1–1889.1.

In male Dipnoans, Müllerian ducts have disappeared in adults of Lepidosiren but persist in Protopterus. Kerr, J. G. 1901.1.

Müllerian ducts persist in adult males of Chimæra. Hyrtl, C. J. 1854.3.

Matthews records the presence (teratological) of a fully developed Müllerian duct on the left side of a male of Raja clavata. Matthews, J. D. 1885.1.

References to the Teleostean oviduct will be found below under Phylogeny of the Teleostean oviduct.

Opisthonephros inclusive of the mesonephros

A recent term, "opisthonephros," is defined by Prof. Kerr (Text-book, p. 221) as follows: "In many of the lower vertebrates there is no separation between mesonephros and metanephros, the two forming a continuous structure which acts as the functional kidney. Such a type of renal organ, consisting of the series of tubules corresponding to mesonephros together with metanephros, may conveniently be termed the opisthonephros."

The opisthonephros forms the functional kidney in adults of all anamniotic vertebrates.

MORPHOLOGY BY GROUPS

Urinogenital system of Cephalochordata

In Amphioxus the chief renal organs consist of many (about 100) pairs of minute nephridia discovered independently by Boveri and by Weiss.

Structure of the excretory organs in Amphioxus. ★Boveri, T. 1890.1–1904.1; ★Goodrich, E. S. 1902.1,.2, 1903.1, 1909.1; Müller, W. 1875.1; Rolph, W. 1875.2; Weiss, F. E. Add. 1890.1.

Structure of the reproductive organs. Legros, R. 1896.1, 1909.1; Neikert, L. & Leiber, A. 1903.1; ★Zarnik, B. 1904.1, 1911.1.

Urinogenital system of Cyclostomata

Reproductive Organs

There is no connection between the excretory and reproductive organs in the Cyclostomata. The genital products (eggs and sperms) are liberated into the cœlom and pass out through the genital pores.

Structure of reproductive organs in Bdellostoma. Cunningham, J. T. 1886.2.

Structure of reproductive organs in Myxine. Cunningham, J. T. 1887.2; Schreiner, K. E. 1904.1,.2; Weber, M. C. 1887.2,.3.

The reproductive organ of Myxine is said to possess the combined structure of ovary and testis (ovotestis) and to function as both, i. e., as a protandric hermaphrodite. For a further discussion, see under Hermaphroditism.

MYXINOIDES

Excretory Organs

The excretory system of the Myxinoids is the most primitive in craniates. The nephridial tubules develop as a continuous series, the intermediate tubules later degenerating (anterior remaining as pronephros) when the posterior part of the organ (mesonephros), extending over between twenty and thirty somites each with its tubule and Malphigian body, becomes the functional organ. Some workers (Semon, R. 1897.1) have considered the functional kidney to be a pronephros, but this view is now generally considered to be in error.

Structure and development of the excretory organs in Myxine. Joseph, H. 1905.1; Kirkaldy, J. W. 1894.1; Maas, O. 1897.2; Müller, W. 1873.2; Semon, R. W. 1897.1,.2; Semon, R. W. & Spengel, J. W. 1897.1; Spengel, J. W. 1897.1,.2.

Structure and development in Bdellostoma. Dean, B. 1899.6; Felix, W. 1897.2; ★Price, G. C. 1897.1–1910.1; Weldon, W. F. 1884.2.

A recent paper by ★J. L. Conel *on* "The urinogenital system of Myxinoids" *appears in the* Journ. Morphol., 1917, vol. 29, pp. 75–138, 12 pls.

Urinogenital Syst. — *Cont'd.*

PETROMYZONTES

Excretory Organs

In the lampreys, the pronephros is most developed and functional in the larval Ammocœtes of 10 mm. length. The mesonephros is likewise functional in this stage and later develops to extend over about two-fifths of the body length.

Structure and development of the excretory organs in Petromyzon. Bujor, P. 1891.1; ★Hatta, S. 1897.2, 1900.1; Meyer, F. 1876.1; Müller, J. 1834.1 (v); Müller, W. 1875.1; Regaud, C. & Policard, A. 1901.1; Vialleton, L. 1890.1; ★Wheeler, M. W. 1899.1.

Urinogenital system of Dipnoi

Genito-urinary organs of breeding males of Lepidosiren and Protopterus. ★Kerr, J. G. 1901.1.

Urinogenital system of Lepidosiren and Protopterus. Ehlers, E. H. 1895.1; Kerr, J. G. 1902.2; Parker, W. M. 1888.2; Semichon, L. (*Ovary*) 1913.1.

Pronephros of Neoceratodus, development. ★Semon, R. W. 1901.3,.4,.6; Wilson, G. 1901.1.

Urinogenital system of Elasmobranchii

The most comprehensive treatise on the urinogenital system of the Elasmobranchii (text in French), including a review of the literature, is ★Borcéa, J. **1905.1.**

A scholarly treatise in German, on the development of the urinogenital system of Selachii, is ★Rabl, C. **1896.1.**

Other papers on the development are ★Balfour, F. M. 1874.1, 1876.2, 1878.2; ★Rückert, J. 1888.2, 1889.2; ★Semper, C. G. 1874.1–**1875.3,** Add. 1874.1; ★Wijhe, J. W. 1888.1,.2, 1889.1.

PLAGIOSTOMI

Reproductive organs

Structure and development of the ovary in Selachii. Balfour, F. M. 1878.3; Giacomini, E. 1894.1, 1896.1; Rathke, M. H. 1827.1.

Ovarian follicle and corpus luteum of Spinax. Wallace, W. 1903.1.

Mechanism of hymen in Plagiostomes. Widakowich, V. 1908.1.

Older papers on the structure of the testis in sharks and rays. Hallmann, E. 1840.1; Martino, A. 1848.1; Müller, J. 1831.1; Stannius, F. H. 1840.1.

Miscellaneous early papers on the reproductive system of sharks, references in Pre-Linn. *section.* Belon, P. 1551.1; Collins, S. 1685.1; Duverney, J. G. 1733.2; Klein, J. T. 1740.1 (iii); Steno, N. 1675.1.

For an old but extensive account of the reproductive organs of Plagiostomes with an excellent review of the old literature, see Tilesius von Tilenau, W. G. 1802.1.

For the structure of the oviduct in adult Selachii, see Uterus *below* Viviparity *under* Reproduction.

For the manner of formation of the horny egg-cases of Elasmobranchii through secretion by the nidamental gland of the oviduct, see below Egg-cases *under* Ova and ovum.

Excretory organs

Older papers on the structure of the excretory organs in Selachii. Hyrtl, C. J. 1861.3; Meyer, F. 1875.1; Müller, J. 1842.1,.3; Steenstra-Toussaint, A. 1834.1–1839.2.

Morphology of mesonephros in numerous forms, Notidanus, Centrina, etc. Borcéa, J. 1904.1–1905.2.

The pronephros is never functional as an excretory organ.

Development of pronephros in Chlamydoselachus, Acanthias, and Scyllium. Brohmer, P. 1908.1; Haller, B. 1901.1; Laguesse, G. E. Add. 1891.3; Burlend, T. H. Add. 1914.1.

Occasionally, because of the influence of other viscera, there are variations in size; a dwarfed kidney may occur on one side, as recorded in Raja by Howes, G. B. 1890.4.

Although usually obliterated during development, as first noted by Semper, (entonnoirs segmentaires) open peritoneal funnels (incorrectly called nephrostomes) may persist throughout life in certain sharks such as *Cestracion*, *Scyllium canicula*, *S. stellare*, *Pristiurus*, *Spinax niger*, *Acanthias vulgaris*, *Scymnus lichia*, *Centrina salviani*, and *Rhina squatina.*

Structure and arrangement of the open peritoneal funnels. Borcéa, J. 1905.1; ★Guitel, F. 1897.1, 1900.2; Schneider, G. 1897.1; Semper, C. G. 1874.1–1875.3.

Bles believes that when the peritoneal funnels persist, the abdominal pores tend to be reduced and vice versa. ★Bles, E. J. 1898.1,.2.

Cloacal cavity of some Selachii, anatomy. Savouré, P. 1910.1.

In male Elasmobranchs, the anterior end of the mesonephros is glandular and entirely lacking in Malphigian corpuscles. It secretes a whitish fluid, variously considered to supply a nourishing medium for the spermatozoa or (in *Chimæra*) to dissolve the investments of the spermatophores. It is known as Leydig's gland.

Structure and functions of Leydig's gland in sharks. Borcéa, J. 1904.1,.6, 1905.1; Disselhorst, R. 1904.1; Morgera, A. 1909.1.

HOLOCEPHALI

In Chimæra the gland just mentioned was first described as a "Nebenhoden," in Leydig, F. Add. 1851.1.

By Hyrtl, it was named Leydig's gland. Hyrtl, C. J. 1854.3.

Other papers describing this gland or the urogenital system of Chimæra, are ★Burlend, T. H. 1910.1; Parker, W. N. & Burlend, T. H. 1909.1; Redeke, H. C. 1898.1.

Reproductive organs of Chimæra, especially ovaries and oviducts. ★Dean, B. 1906.1.

Vesiculæ seminales of male Callorhynchus. Parker, T. J. 1892.1.

Urinogenital System of Teleostomi

GANOIDEI

Morphology of the urinogenital system of Ganoidei in general. ★Hyrtl, C. J. 1854.2; Semon, R. W. 1891.1.

CROSSOPTERYGII

Development of pronephros in Calamoichthys. Jungersen, H. F. 1895.1; Lebedinsky, J. 1894.1.

Urinogenital organs of Polypterus. Jungersen, H. F. 1900.1.

Development of opisthonephros in Polypterus. Kerr, J. G. 1907.2.

CHONDROSTEI and HOLOSTEI

Development of embryonic cloaca, urinogenital sinus, and Müllerian duct in Acipenser. Ostroumov, A. A. 1906.1.

Development and structure of the pronephros in —Lepidosteus. Balfour, F. M. & Parker, W. N. 1882.1; Beard, J. 1895.2. —*Acipenser.* Jungersen, H. F. 1894.2. —*Amia.* Jungersen, H. F. 1894.1; Kupffer, C. W. 1893.1 (i).

In Ganoids, open peritoneal funnels persist only in Amia. Jungersen, H. F. 1894.1, 1900.1.

Preservation of remains of testis in fossil Eurycormus. Reis, O. M. 1894.2.

TELEOSTEI

Excretory Organs

In the Teleosts, the pronephros extends over about five segments, is functional in larval forms, and, except as stated below, is generally transitory.

For the most extensive treatise (in French) on the morphology of the Teleostean kidney, with a review of the literature, see ★Audigé, J. **1910.1**.

Morphology and development of pronephros, mesonephros, and opisthonephros in Teleosts. Calderwood, W. L. 1892.3; ★Felix, W. **1897.1**; Goette, A. 1875.1; ★Haller, B. 1908.2; ★Hyrtl, C. J. 1851.2; Parker, W. N. 1882.1; Rosenberg, A. 1867.1; Roule, L. & Audigé, J. 1908.1; Sobotta, J. 1895.1.

Morphology of the kidney in various forms. —*Cyprinidæ.* Gampert, O. 1866.1,.2. —*Lophobranchii.* Huot, A. 1897.1. —*Amiurus.* Mackenzie, T. 1884.1. —*Gastrostomus, Argyropelecus and Chauliodus.* Nusbaum-Hilarowicz, J. 1915.3. —*Clarias.* Weber, M. C. 1891.1.

Urinogenital organs of the male in Clarias. Panceri, P. 1874.1.

Persistence of pronephros. While generally transitory, the pronephros as represented by large functional glomeruli is said to persist in certain adult Teleosts. Emery described this condition as occurring in adults of *Fierasfer*, *Atherina*, *Mugil*, and *Zoarces*. After a controversy with Grosglik, he admitted that possibly his specimens of the three latter forms were immature but reaffirmed the existence of the pronephros in the adult of *Fierasfer*. The actual persistence of functional pronephric glomeruli in Teleosts is doubted by Audigé and by Haller. For a full discussion of this subject, *see* Audigé, J. 1910.1, pp. 289–297.

Concerning the persistence of the pronephros in Fierasfer, see Emery, C. 1880.1, 1881.2, 1882.1, 1885.1; *and* Grosglik, S. 1885.1,1886.1.

According to Guitel, the pronephros persists in various species belonging to the genera, *Chorisochismus*, *Lepadogaster*, *Caularchus*, *Gobiesox*, *Callyonymus*, *Gobius*, *Cottus*, *Aspidophorus*, *Trachinus*, *Blennius*, *Centronotus*, and *Atherina*. *See* ★Guitel, F. 1900.1, 1901.1–1908.1, 1910.1, .2, 1912.1, 1913.2.

Urinary bladder. The urinary bladder in Teleosts is constituted by the part formed through the posterior fusion of the two archinephric ducts, together with the terminal part derived from the cloaca.

Structure of urinary bladder in —Barbus. Audigé, J. 1904.3. —*Trachinus.* Chaine, J. 1909.1. —*Absence in certain fishes.* Hyrtl, C. J. 1849.1. —*Development.* Kupffer, C. 1868.1. —*Relation to cloaca.* List, J. H. 1889.1. —*Urinary canal.* Policard, A. & Mawas, J. 1906.1.

For the chemical composition of the urine of fishes, see under Chemistry.

Reproductive Organs

For all reproductive or breeding and mating habits, *see under* Reproduction.

For the occurrence of genital organs of both sexes in the same individual, *see under* Hermaphroditism.

For the reproductive elements, *see* Ova and ovum *and* Spermatozoa.

For the origin and migration of the germ cells, *see* that subject *under* Embryology.

Reproductive organs, morphology and development. ★Böhi, U. (*Salmonidæ*) 1904.1; Brock, J. 1878.1, (*Murænoids*) 1881.1; ★Weber, M. C. 1886.1; Cunningham, J. T. (*Solea*) Add. 1888.2.

Studies on the ovaries of fishes, anatomical histological, etc., chiefly made in connection with studies on the development of the ovarian ova. Structure in —General. Auerbach, L. 1891.1; Calderwood, W. L. 1892.1; Cunningham, J. T. 1893.9, 1897.3, 1898.1. —*Lophius and Zeus.* Fulton, T. W. 1898.3. —*Lophius.* Mocquard, F. Add. 1888.1. —*Gobius minutus.* Guitel, F. 1892.3. —*Lucifuga and Stygicola.* Lane, H. H. 1903.1, 1908.1, 1909.1. —*Clupea.* Loewe, Fr. 1896.1. —*Anarrhichas.* McIntosh, W. C. 1885.2. —*Lophobranchii.* MacLeod, J. 1881.1,.2,.3. —*Labrax.* Roule, L. 1914.7. —*Zoarces.* Stuhlmann, F. L. 1887.1. —*Engraulis.* Weber, M. C. 1886.2,.3. —*Sebastes and Sparus.* Williamson, H. C. 1911.4. —*Ophidium.* Hyrtl, C. J. Add. 1849.1.

Phylogeny of the Teleostean oviduct. The homologies of this duct, *i. e.*, whether or not it is a Müllerian duct as above defined, are still debatable points in morphology.

Prof. J. G. Kerr in the "Encyclopædia Britannica" (1910, vol. xiv, p. 256), wrote as follows: "In the great majority of Teleosts and in *Lepidosteus* the oviduct possesses no cœlomic funnel, its walls being in structural continuity with the wall of the ovary. In most of the primitive Teleostomes (Crossopterygians,

Urogenital Syst. — *Cont'd.*

sturgeons, *Amia*) the oviduct has at its front end an open cœlomic funnel, and it is difficult to find adequate reason for refusing to regard such oviducts as true Müllerian ducts. On this interpretation the condition characteristic of Teleosts would be due to the lips of the oviduct becoming fused with the ovarian wall, and the duct itself would be a Müllerian duct as elsewhere."

More recently Professor Kerr (Textbook, 1919, p. 278) in contrast with the above statements has formulated the following views regarding the Teleostean oviduct.

(1) The primitive oviduct or *Müllerian duct* gradually atrophied until eventually nothing was left but its external opening, the genital pore.

(2) The splanchnocœle along the ovigerous surface became enclosed by peritoneal folds, the anterior part of this cavity remaining fertile, the elongated posterior portion becoming sterile and serving simply as a conducting tube for the ova (oviduct).

(3) The posterior lips of this *secondary oviduct* became fused with the edges of the genital pore, which thus *again* becomes the oviducal aperture.

These divergent views adequately represent the alternative theories regarding the nature of the Teleostean oviduct.

The latter type of oviduct, considered nonhomologous with the Müllerian duct, has been termed *ovary-duct* by Howes, (G. B. 1891.1, p. 551).

Various papers describing the structure and development of the oviducts in various Teleosts are Böhi, U. 1904.1; Cunningham, J. T. 1887.3; ★Haller, B. 1905.1; Howes, G. B. 1891.1,.2; Huxley, T. H. 1883.2; ★Lickteig, A. 1913.1; MacLeod, J. 1881.3; Nussbaum, M. 1880.1; Nussbaum-Hilarowicz, J. 1915.1; Prince, E. E. 1887.1; Rathke, M. H. 1820.2; Schneider, G. 1894.1, 1895.2; Vogt, C. C. 1882.2; Weber, M. 1886.1.

The Teleostean oviduct arises as a peritoneal derivative formed after the differentiation of the ovary, and it subsequently becomes connected with the ovarian investment, according to ★Jungersen, H. F. 1889.1 (p. 179), *who believes that the Teleostean oviduct may be regarded as a modified Müllerian duct.*

The view which has long been held that oviducts are absent in Salmonidæ (Rathke, M. H. 1820.2; Weber, M. 1886.1) *is considered erroneous by* W. C. Kendall (Bull. U. S. Bur. Fish., 1921, vol. xxxvii, p. 189), *who describes an oviducal trough formed by the ovarian investments.*

VARIATION

This section includes only detailed statistical studies, by the examination of large numbers of individuals, on the occurrence or frequency of variation in certain characters chosen for study, such as the number of scales, fin rays, color markings, etc.

These studies were largely influenced by the concept of Bateson with regard to discontinuity in the origin of species.

For references to all abnormal variations in structure, *see under* Teratology.

Other references to slight variations within the species will be found under the various families and genera.

Materials for the study of variation. ★Bateson, W. 1894.1. — *Method for the expression of measurements.* Camerano, L. 1900.1, 1901.1. — *Progressive reduction of variability.* Rosa, D. 1903.1.

Miscellaneous papers on variation. Bumpus, H. C. 1898.6; Eigenmann, C. H. 1892.7; Eigenmann, C. H. & Kennedy, C. H. 1903.2; ★Fatio, V. 1877.1, 1899.1; Heincke, F. 1892.1; Meek, S. E. 1900.3; Nichols, J. T. 1911.2, 1916.5; Walton, L. B. 1907.1.

Detailed researches on the variation in various chosen characters have been made as follows. — *Pilchard.* Bateson, W. 1894.3. — *Flounder.* ★Duncker, G. 1895.1,.2, 1896.1, 1900.2. — *Review of this work.* Stead, F. B. 1897.4. — *Acerina.* Duncker, G. 1897.1. — *Siphonostoma.* ★Duncker, G. 1908.1. — *Leuciscus balteatus.* Eigenmann, C. H. 1895.2. — *Mullus.* ★Fage, L. 1909.1. — *Mackerel.* Garstang, W. 1897.3, 1898.1. — *Herring.* ★Heincke, F. 1877.1. — *Percina caprodes.* ★Moenkhaus, W. J. 1893.1–1898.1. — *Petromyzon.* Rosmini, O. 1901.1. — *Tench.* Segre, R. 1902.1. — *Triglidæ.* Tillier, L. 1879.2. — *Pimephales notatus.* Voris, J. H. 1899.1.—*Gasterosteus.* Heincke, F. Add. 1889.1.

Meristic variation in Asymmetron and Heteropleuron. Punnett, R. C. 1903.1.

Statistical studies on fish races. Redeke, H. C. 1902.1, 1912.2.

For the recent statistical racial studies of J. Schmidt, involving breeding experiments, see Genetical work *under* Hybrids.

VERTEBRAL COLUMN

Comprising the development and structure of the notochord, the chordal sheath, the arcualia, the centra and the definitive vertebræ.

For cases of palistrophy (coalesced vertebræ) notochordal reduplications, spinal curvature, etc., in fishes, *see below* Abnormalities of skull and vertebral column *under* Teratology.

For the vertebral theory of skull origin, *see under* Skull.

For the termination of the vertebral column in the tail of fishes, *see below* Caudal fin *under* Fins.

For the coalescence of the anterior vertebræ with the occipital region of the skull and the transformation of certain parts into the Weberian ossicles, *see* Weberian apparatus *under* Auditory organs.

For the most illuminative treatise in English on the development and morphology of the vertebral system in all groups of fishes, see ★Gadow, H. & Abbott, E. C. **1894.1.**

This has served as a basis for the readable chapter in ★Bridge, T. W. 1904.1.

Comprehensive treatises in German, relating to development and morphology in all groups of vertebrates. ★Goette, A. 1878.1 *and* ★Schauinsland, H. Add. **1905.1.**

VARIOUS TOPICS

Papers on the notochord: development, histology and histogenesis, phylogeny, etc. Boeke, J. 1902.4; Henneguy, L. F. 1907.1;

★Kemna, A. 1904.1; Masterman, A. T. 1898.1; Mayer, A. F. 1865.1; Retzius, M. G. 1881.1; Schaffer, J. 1901.2 (iii), 1910.1; ★Studnička, F. K. 1897.2,.3, 1902.1, 1903.2; Valenti, G. 1898.1; Müller, W. Add. 1871.1 (i).

Hypochord, or sub-notochordal rod. —*Development in teleosts.* Franz, K. 1897.1. —*In Raja.* ★Gibson, W. T. 1909.1. —*Morphological significance.* Klaatsch, H. 1897.2. —*Origin, Selachii.* Weber, A. 1913.1.

Relations of temperature to number of vertebræ. Jordan, D. S. 1892.2, 1893.2, 1894.3. —*Mode of union of vertebræ after fracture, Solea.* Yarrell, W. 1835.1.

Various papers on the development, morphology, phylogeny, etc., of the vertebral column. (The forms to which they relate are not indicated in the titles.) Baur, G. H. 1886.1; Dormitzer, M. 1852.1; Dollo, L. 1893.2; Geoffroy-Saint-Hilaire, E. 1821.1, 1822.1,.3; ★Gaupp, E. 1897.1; Hay, O. P. 1896.2, 1897.1,.2; Home, E. 1809.2; Ihering, H. 1878.2; Jaekel, O. 1904.2; Lavocat, A. 1884.1, 1885.1; Müller, A. 1853.1; Spencer, H. 1900.1; Stannius, F. H. 1849.2; Suster, M. 1899.1; Welcker, H. 1878.1; Bruch, C. Add. 1862.1,.2; Cartier, O. Add. 1875.1; Schultze, C. A. Add. 1818.1.

Notochordal sheath

The cuticular product of the notochord which it surrounds; composed of the Elastica Interna or original border of the chorda, the secondary sheath often invaded by cortilage cells, and the Elastica Externa (primary sheath) or outermost boundary of the entire chordal sheath.

Development, structure, etc. Ebner, V. 1896.6,.7; Kölliker, R. A. 1860.2; Lvov, V. N. 1887.1; Pèrenyi, J. 1887.1; Schneider, O. 1913.1; Claus, C. Add. 1894.1.

History of investigations of the notochordal sheath. Kölliker, R. A. Add. 1872.1.

VERTEBRAL COLUMN

Morphology in various groups of fishes

Following Gadow and Abbott we are able to distinguish two types in the formation of the centra or bodies of the vertebræ.

I. "*Chorda-centra, i. e.*, centra formed by the entire chordal sheath, which itself has been strengthened by invasion of cartilaginous cells from the skeletogenous layer. Chorda centra are possessed by all Elasmobranchs, potentially by Dipnoi and Holocephali."

II. "*Arch-centra, i. e.*, centra formed by the skeletogenous mass which remains entirely on the outside of the chordal sheath, which latter takes no share in their formation: osseous Ganoids and Teleostei."

Cephalochordata

In this group, the vertebral axis is composed of the primitive notochord.

Structure and development of the notochord in Amphioxus. Ebner, V. 1896.2; Harting, P. 1879.2; Kossmann, R. A. 1873.1; Lubach, D. 1870.2; Lvov, V. N. 1893.2, Add. 1891.1, 1892.1; Moreau, E. 1870.1,.2, 1875.1; Pouchet, G. 1881.2; Renault, J. & Duchamp, G. 1878.1; Repiachoff, W. 1883.1; Retzius, M. G. 1891.1; Rolph, W. 1875.1; Joseph, H. Add. 1895.1; Mihalkowics, V. Add. 1876.1.

Cyclostomata

A persistent acentrous notochord; the skeletogenous layer remains outside the elastica externa so that the chordal sheath remains entirely chordagenous. Dorsal processes probably representing basi- and inter-dorsals. No ventral arcualia.

Structure and development, chiefly in Petromyzon. Calberla, E. 1877.2; Ebner, V. (*Myxine*) 1896.3,.5; Geoffroy-Saint-Hilaire, E. 1821.1; Goette, A. 1878.1,.4; Hasse, J. C. 1894.1; Pérépelkine, K. 1878.1; Retzius, M. G. 1892.2; Schneider, A. F. 1879.1 (p. 51); Scott, W. B. 1882.1.

Arthrodira

In Dinichthys, the vertebral column consists of slightly calcified neural and hæmal arches and a persistent notochord. Dean, B. 1896.7.

Elasmobranchii

In this group the centra (chorda-centra) are formed by the conversion of the chordal sheath into a series of ring-like cartilaginous segments which replace the notochord. The centra may become calcified but true bone is never developed.

Structure and development of the vertebral column; composition of the definitive vertebræ, etc. Gadow, H. 1900.1; ★Hasse, J. C. 1876.1, 1877.1, 1878.1, **1879.1,.2,** 1892.2; ★Kölliker, R. A. 1860.2,.7, 1864.1; Müller, J. 1837.1; Müller, J. & Agassiz, L. 1843.1; Perenyi, J. 1887.1, 1889.1; Rosenberg, E. W. 1884.1; ★Sécerov, S. 1911.1; Stark, James. 1844.2.

For fine figures of the vertebral column of various Elasmobranchs see Garman, S. 1913.1.

HOLOCEPHALI

Centra are not formed in the Holocephali.

Structure of vertebral column in Holocephali (Chimæra). Gegenbaur, C. 1898.1; Hasse, J. C. 1879.1; Howes, G. B. 1902.1; Schultze, C. A. 1818.1.

Teleostomi

CHONDROSTEI
(Cartilaginous Ganoids)

"The chorda shows uniform and persistent growth throughout life. The skeletogenous layer remains restricted to the outside of the elastica and produces dorsal and ventral arcualia which remain laterally asunder, being there connected by the membrana reuniens only."

Vertebral Column — *Cont'd.*

This quotation concerning Acipenser is from Gadow, H. & Abbott, E. C. 1894.1.

Histology of chorda in Acipenser. Ebner, V. 1896.4.

HOLOSTEI

(Osseous Ganoids)

In this group, osseous arch-centra are formed.

Structure and development of vertebral column. Hasse, J. C. 1894.2.

Structure and development in Amia calva. ★Hay, O. P. 1895.3; Ihering, H. 1878.2; Schmidt, L. 1892.1.

Structure and development in Lepidosteus. (*This form is unique among fishes in possessing opisthocœlous vertebræ.*) Balfour, F. M. & Parker, W. K. 1882.1; C., E. 1868.1; ★Gegenbaur, C. 1867.1.

The older groups "Amioidei" and "Lepidosteoidei" were rejected by Woodward and the genera partly redistributed into new suborders, the Protospondyli and the Ætheospondyli, based on the structure of the vertebral column. For a discussion of their taxonomic status, see Hay, O. P. 1898.1,.6.

Much information on the vertebral column of fossil ganoids will be found in Woodward, A. S. 1889.2, *and in* Zittel, K. A. 1887.1.

TELEOSTEI

(Bony fishes)

"The centrum is formed entirely by the skeletogenous layer remaining outside the elastica, its cartilage is derived from the dorsal and ventral arcualia." This cartilage surrounds the chordal sheath with a complete mantle (Rhodeus), and is ossified later on. In the trout, most of the material necessary for the formation of the centrum is indifferent membrana reuniens and ossifies directly.

Papers primarily on the development of the vertebral column in teleosts. Albrecht, A. 1902.1; Alessi, C. (*Clupeidæ*) 1898.1; Calberla, E. 1877.2; Goette, A. 1873.1 (v), 1878.4; Goronowitsch, N. (*Salmonidæ*) 1885.1; ★Grassi, G. B. 1883.1–1885.1; ★Klaatsch, H. 1892.1; Lotz, T. 1864.1; Reinhard, W. (*Cyprinoids*) 1888.1; Roule, L. 1908.3; ★Scheel, C. 1893.1; Sella, M. (*Murænidæ*) 1911.2; ★Stéphan, P. 1898.1, 1900.1; ★Ussow, S. A. 1900.1, 1906.1; Wyman, J. 1856.2.

Structure or morphology of the vertebral column or the definitive vertebræ. — Teleostei. Battista, G. 1883.1. — *Doras.* Bliss, R. 1872.2. — *Muræna.* Ciamician, J. 1878.1. — *Cobitidæ.* Grobben, C. 1875.1. — *Clupeidæ.* Lombardo, A. C. 1884.1.

Absence of true articular apophyses, teleosts. Alix, E. 1874.1. — *Cervical and occipital vertebræ of Teleosts.* Robertson, C. 1861.1.

Dipnoi

Chordal sheath strengthened by invasion of skeletogenous cells, therefore with possibility of chorda-centra, but the partly chondrified chordal sheath remains unsegmented, *i. e.*, no centra are formed.

Structure in Dipnoi. Günther, A. C. 1871.3; Hasse, J. C. 1892.1; Klaatsch, H. 1893.1; Wiedersheim, R. E. 1880.2.

VISCERAL SKELETON

Comprising the structure of the visceral and branchial arches. Although primitively cartilaginous, in the Teleostei these parts are ossified as cartilage bones. The visceral skeleton consists of a series of supporting bars, the visceral arches, arising in the mesenchymatous tissue between the visceral clefts. The two anterior visceral arches are specially designated, the first is the mandibular and the second is the hyoid arch. The remaining arches are collectively called branchial or gill arches.

For the musculature of the visceral arches, *see* Cranial and visceral muscles *under* Myology.

Embryonic development of the visceral arches, their topographic role, etc. Braus, H. 1904.2; ★Dohrn, F. A. 1882.2 (vii); Froriep, A. 1891.1; ★Vialleton, L. 1908.2. — *Development in Lepidosiren and Protopterus.* Agar, W. E. 1906.1. — *Selachii.* ★Gibian, A. 1912.1. — *Syngnathus.* McMurrich, J. P. 1883.1. — *Sharks and skates.* ★Parker, W. K. **1879.2**. — *Acanthias.* ★Severtzov, A. N. 1899.1. — *Teleostei.* Voskoboĭnikov, M. M. 1910.1. — *Salmo.* Zanichelli, W. 1909.1.

Morphology of the visceral skeleton or "Ligamentum denticulatum" of Amphioxus. Benham, W. B. 1893.1; Rolph, W. 1875.2.

Morphology of the visceral skeleton of Cyclostomata, chiefly Petromyzon, the so-called "hyobranchial skeleton" or "branchial basket." Alix, E. 1880.1; Ayers, H. & Jackson, C. M. 1900.1; Burne, R. H. 1892.1; Dohrn, F. A. 1882.2 (v); ★Huxley, T. H. 1876.2; Kupffer, C. W. 1895.1; Neumayer, L. 1910.1; ★Parker, W. K. **1883.1**; Schaffer, J. 1901.2; Severtzov, A. N. 1914.1; Gaupp, E. Add. 1904.1.

Morphology of the visceral skeleton in adult Selachii. ★Fürbringer, K. **1903.1**; ★Gadow, H. 1888.1; Garman, S. (*Fine figures*) 1913.1; ★Gegenbaur, C. 1864.2 (iii); Molin, R. 1859.1. — *Chlamydoselachus.* Goodey, T. 1910.1. — *Echinorhinus.* Ridewood, W. G. 1899.1. — *Læmargus.* White, P. J. 1893.1. — *Pristiophorus.* ★Hoffmann, L. Add. 1914.1.

Morphology of the visceral skeleton in the Chimæroid or "holocephalic" skull. Dean, B. 1906.1; Hubrecht, A. A. 1876.1; Woodward, A. S. 1889.2 (ii).

Morphology of visceral skeleton in Ganoidei and Neoceratodus. ★Wijhe, J. W. 1880.1, 1882.1.

Morphology of visceral skeleton in Symbranchidæ. Weyenbergh, H. 1878.4, 1881.1.

Relations of mandibular and hyoid arches in Hybodus. Woodward, A. S. 1886.3.

Derivatives of mandibular and hyoid arches with especial references to the homologies of the mammalian auditory ossicles. Albrecht, P. 1884.1; Gadow, H. 1888.1; Debierre, C. Add. 1885.1.

Visceral arch theory of origin of jaw. Jaekel, O. 1905.1, 1906.4, 1907.1.

Labial cartilages of sharks, often considered remnants of pre-mandibular arches. Pollard, H. B. 1895.3.

Suggestion of former existence of an arch and an additional visceral cleft between mandibular and hyoid arches. Beard, J. 1885.2; Dohrn, A. 1882.2 (vii); Wijhe, J. W. 1882.2.

Existence of skeletal elements between the mandibular and hyoid arches in Læmargus and Hexanchus. White, P. J. 1895.1.

HYOID ARCH

Anatomy of the hyoid arch in Neoceratodus. Ridewood, W. G. 1894.1.

Anatomy of the "tongue-bone," being the median basi-hyal element of the second visceral or hyoid arch. Budge, J. (*Sphyræna*) 1848.1; Dohrn, F. A. 1882.2 (vii); Eichwald, C. E. 1833.1; Geoffroy-Saint-Hilaire, E. 1817.3, 1832.1.

For the fleshy tongue, see below Oral cavity *under* Alimentary canal.

For the conditions of the suspension of the lower jaw to the hyomandibular or proximal sector of the hyoid arch, see under Skull. *See especially* ★Gregory, W. K. 1904.2.

Branchial or gill arches

Development in Selachii. ★Dohrn, F. A. 1882.2 (ix, xi, xii). — *Phylogeny.* Gaskell, W. H. 1898.1 (iii). — *Development.* Remak, R. 1855.1.

Structure in — Murænidæ. Popta, C. M. 1904.1. — *Dentex.* Vinciguerra, D. 1893.4.

Presence of vestigial sixth and seventh arches, respectively in Notidanus and Chlamydoselachus. Hawkes, (Mrs.) O. A. 1905.1, 1907.1.

Gill rakers: cartilaginous or bony filaments on the inner side of the branchial arches. — Comparative studies on their structure in various fishes. Popta, C. M. 1901.2,.3; Troschel, F. H. 1849.2; ★Zander, E. 1903.2, 1906.1,.2.

Although forming a straining mechanism in all fishes, in some genera they form an exceptionally close-set branchial sieve. Such structure in — Polyodon. Imms, A. D. 1904.1. — *Rhineodon.* Lütken, C. F. 1874.2. — *Basking shark (Cetorhinus).* Allman, G. J. 1876.1; Bocage, J. V. 1878.1; Day, F. 1885.3; Hendricks, K. 1908.1, 1909.1; Leriche, M. 1908.8; Pavesi, P. 1874.1; Steenstrup, J. J. 1873.1, 1875.1; Turner, W. 1879.2; Macalister, A. Add. 1879.1. — *Mobula.* Vaillant, L. L. 1912.1.

Extrabranchial cartilages of Elasmobranchs. Foote, E. 1895.1; Fürbringer, M. 1903.2; Ridewood, W. G. 1897.1; White, P. J. 1896.1.

For the branchial filaments, see Gills *under* Respiratory organs.

For the interbranchial or respiratory muscles, see Cranial and visceral muscles *under* Myology.

For the "branchial arch hypothesis" of the origin of limbs (Gegenbaur's view), see Phylogenesis of limbs *under* Evolution.

Visceral clefts

Called also pharyngeal, branchial, and gill clefts.

Development of the visceral clefts. ★Dohrn, F. A. 1882.2 (xxiii, xxiv); Masterman, A. T. 1898.1; Spengel, J. W. 1904.1; Vialleton, L. 1906.1.

Additional references to such development will be found under Head.

Presence of seven visceral clefts in shark embryos. Bemmelen, J. F. 1886.1.

Arrangement, Selache maxima. Jaekel, O. 1890.1.

For the hyomandibular cleft, i. e., cleft between mandibular and hyoid arches, a functional vestige in fishes when present, see Spiracle *under* Respiratory organs.

For Dohrn's theory of the origin of the mouth through the coalescence of a pair of gill clefts see Oral cavity *under* Alimentary canal.

VISION

For the organ of vision, *see* Eye.

For "color vision," *see* Color perception *under* Behavior.

For the influence of vision on Changes in Coloration, *see under* Coloration.

For the latest and most comprehensive papers on vision in fishes, see Baglioni, S. 1910.1; ★Hess, C. 1911.1, 1913.1, Add. **1912.1**, 1914.1; Tschermak, A. 1915.1.

Miscellaneous items. Franz, V. 1907.4; Fripp, H. E. 1866.1; Henshall, J. A. 1878.1; Jeffries, B. J. 1869.1; Milewski, A. 1915.11; Plateau, F. A. 1866.1,.2; Reinhardt, L. 1902.1; Ward, F. 1908.1; Brunton, J. Add. 1882.1; Edwards, G. Add. 1763.1; Lanik, A. Add. 1914.1; Vigueron, H. Add. 1913.1; Wernicke, O. Add. 1895.1.

Various researches, chiefly experimental. — Binocular vision. Apgar, A. C. 1886.1; ★Tschermak, A. 1902.1, 1914.1. — *Subaqueous vision.* Dudgeon, R. E. 1871.1; Wood, R. W. 1906.1, Add. 1906.1. — *Vision, deep-sea fishes.* Chun, C. 1893.1. — *Influence of vision on movements, Mustelus.* Parker, G. H. 1910.2.

Rheotropism considered an optical reflex. Lyon, E. P. 1905.1, 1909.1.

For effects of excision of eye upon coloration, see under Coloration. *See especially* Buijtendijk, F. J. 1911.1; Lubach, D. 1864.2; Pouchet, G. 1877.1, 1879.1.

Accommodation in vision. *In fishes accommodation is accomplished through the pulling inward and backward or retinalward of the lens by the muscle named by Beer, Musculus retractor lentis, which is formed by the Processus falciformis, a median prolongation of the choroid and its expanded outer portion, the Campanula Halleri.*

General accounts, including physiological researches. ★Beer, T. **1894.1**, 1898.1; Brass, A. 1881.1; Deichsel, G. 1908.1; Franz, V. 1905.1, 1910.3; Pflugk, A. 1911.1; ★Sicherer, O. 1911.1; ★Hess, C. Add. 1912.1.

Vision — *Cont'd.*

Discovery of the muscle of accommodation. Dalrymple, J. 1838.1; Leydig, F. 1852.1; Manz, W. 1858.1, Add. 1857.1; Wallace, W. C. 1834.1, 1835.1, 1838.1.

Tensor muscle of choroid in teleosts, homologous with the ciliary muscles which effect accommodation in higher vertebrates. Structure. Grynfeltt, E. 1908.1–1910.4. — *Ciliary muscle considered lacking.* Lee, R. J. 1869.1.

VIII

SUBJECT INDEX

SYSTEMATIC SECTION[1]

CEPHALOCHORDATA (*LEPTOCARDII OR LANCELETS*)

Marine acraniate fish-like chordates.

General treatise. Delage, M. Y. & Hérouard, E. 1898.1; Willey, A. 1894.1.

Classification and geographical distribution. Tattersall, W. M. 1903.1. — *For a map showing the geographical distribution of the Cephalochordata, see* Herdman, W. A. 1904.1 (*p.* 138).

Taxonomy of forms from — Maldive and Laccadive Islands. Cooper, C. F. 1903.1; Parker, G. H. 1904.3. — *Japan.* Jordan, D. S. & Snyder, J. O. 1901.12. — *Ceylon.* Tattersall, W. M. 1903.2.

Family Amphioxididæ

Amphioxides (*A pelagic form*). *Taxonomy and relationships.* ★Goldschmidt, R. 1905.1, 1906.1, 1909.1, Add. **1905.1.** — *Review of the above.* Willey, A. 1906.1.

Family Branchiostomidæ

Marine littoral forms

Taxonomic revisions of genera and species. Gill, T. N. 1895.2; Jordan, D. S. & Snyder, J. O. (*Japan*) 1901.12; ★Kirkaldy, J. W. 1895.1, Add. 1894.1.

Amphioxus (Branchiostoma). *Natural history, descriptions of young, etc.* Bert, P. 1867.1,.5; Clark, H. J. 1865.1; Harting, P. 1876.1; Kemna, A. 1906.1; Krause, W. 1898.1; Lindsay, A. 1857.1; Müller, J. 1839.1, 1841.2; Quatrefages, J. L. 1845.1; Reichert, C. B. 1870.1; Rice, H. J. 1878.1; Schultze, M. J. 1851.1; Schneider, A. F. 1878.1; Sundevall, C. J. 1840.1; Sundewall, F. 1843.1; Willey, A. 1891.1, 1901.1; Yung, E. J. 1906.1; Putnam, F. W. Add. 1865.1.

Phylogenetic relationships. — Relation to Balanoglossus. MacBride, E. W. 1897.1. — *Amphioxus a slightly metamorphosed tunicate (with consideration of homologies).* Wijhe, J. W. 1906.1, 1914.1,.2. — "*Amphioxus and the ancestry of the vertebrates.*" Willey, A. 1894.1.

Asymmetron. *Natural history notes.* ★Andrews, E. A. 1893.1; Benham, W. B. 1901.1, 1901.2; Mark, E. L. 1904.1; Römer, F. 1896.1; Willey, A. 1896.1.

Epigonichthys. *Natural history.* Harting, P. 1877.1; Passzlavsky, J. 1877.1; Peters, W. C. H. 1876.1.

CRANIATA

Animals (Vertebrate) distinguished by the possession of a definite "head."

CLASS CYCLOSTOMATA, *OR MARSIPOBRANCHII.*

Aquatic craniates without true jaws.

For parasitic habits of Cyclostomes, see under Parasitic Fishes, *also pp.* 416 *and* 500.

Natural history. Duméril, A. M. 1812.1, .2; Partiot, L. Add. 1848.1; Thomson, J. A. Add. 1912.1.

Taxonomy and systematic relationships. Dean, B. 1900.1; Gill, T. N. 1883.7; ★Howes, G. B. 1892.1; Woodland, W. N. 1911.4. — *Supposed gnathostome ancestry of Marsipobranchii.* Woodland, W. N. 1913.2.

Taxonomy of species found in — Russia. Berg, L. S. 1906.10. — *Japan.* Jordan, D. S. & Snyder, J. O. 1901.12. — *Australia.* Ogilby, J. D. 1896.2.

ORDER MYXINOIDES
(Hyperotreti)
Hag-fishes or Borers

For a map showing the geographical distribution of the Myxinoides, see Meek, A. 1916.1 (*p.* 31).

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[1] Arranged in general according to the system used in the Cambridge Natural History — this for convenience.

Confined chiefly to natural history, occurrence and the larger and more recent papers on fossil forms and taxonomy. Rarely going below genera, save in the case of the fishes of great economic as well as scientific importance (i. e. Anguilla, Pleuronectidæ, Salmonidæ, etc.).

For further data on natural history, *see* Habits, Reproduction, etc., *in* Morphological Section. For further references to fossil fishes, *see the elaborate section* Palæontology, *also* Hay, O. P. 1902.1, *and* Woodward, A. S. 1889.2, *and also the* Bibliography of North American Palæontology *cited in* Part IV, General Bibliographies. For further data on taxonomy and occurrence, *see section* Fauna of the World, and for particular regions, see such great faunistic and taxonomic works as Day, F. 1875.1, Boulenger, G. A. Add. 1909.1, Eigenmann, C. H. 1912.2, Goode & Bean, 1896.1, Jordan & Evermann, 1896.1. For new species, *see* Zoological Record.

For all other subjects, *see* the Morphological Section.

Taxonomy. Dean, B. (*Japanese forms*) 1904.7; Fürbringer, M. 1900.1; Gill, T. N. 1883.5.

Family Myxinidæ

General account. Retzius, M. G. 1895.1.

Myxine. — *Natural history.* Gunner, J. E. 1766.6; Steenstrup, J. J. 1865.2; Swartz, O. 1790.1. — *Taxonomy; revision.* Regan, C. T. 1913.20.

Family Bdellostomatidæ

Taxonomy. Gill, T. N. 1883.5, 1894.1.

Bdellostoma. — *Nomenclature.* Gill, T. N. 1901.1. — *Taxonomy.* Putnam, F. W. (*Revision*) 1874.5; Regan, C. T. (*Synopsis*) 1912.23.

ORDER PETROMYZONTES
(Hyperoarti)
Lamprey Eels

Taxonomy; synopsis. Regan, C. T. 1911.16.

Family Petromyzontidæ

Natural history. Agassiz, J. L. & Cabot, J. E. 1850.1; Fowler, H. W. 1907.3; Gage, S. H. & Meek, S. E. 1886.1; Surface, H. A. 1898.1, 1899.1.

Taxonomy. General accounts. Agassiz, J. L. 1850.5; Gill, T. N. 1883.8, 1895.6; Goode, G. B. 1883.8; Jordan, D. S. & Gilbert, C. H. 1884.4.

Taxonomy; forms in — Russia. Berg, L. S. 1907.5; Gracianov, V. I. 1907.3, 1907.6. — *Japan.* Hatta, S. 1901.1. — *Sweden.* Malm, A. W. 1860.1, 1863.2. — *Southern Hemisphere.* ★Plate, L. H. 1902.1. — *Australia.* Leach, J. A. Add. 1914.1.

Ammocœtes (*the larval form of Petromyzon*). — *Natural history.* Cederström, G. C. 1861.1; Holfert, H. F. 1870.1; Meek, S. E. 1890.2. — *Evolutionary history.* Gaskell, W. H. 1898.1 (viii).

Metamorphosis of Ammocœtes into Petromyzon. Baur, A. 1867.1; Benecke, B. 1880.3,.7; ★Bujor, P. 1891.1,.2; Gage, S. H. 1891.1, 1893.2, 1894.1, 1898.1, 1899.1; ★Kaensche, C. C. 1890.1.

See also p. 368.

Genera found only in northern waters

For a map showing the geographical distribution of the northern Petromyzontidæ, see Meek, A. 1916.1 (*p.* 28).

Entosphenus (Entersphenus). *Popular account.* Smith, H. M. 1900.3.

Lampetra. *Natural history.* Loman, J. C. 1912.1.

Occurrence — in Kamchatka. Berg, L. S. 1912.5. — *in New Jersey.* Davis, W. T. 1915.1. — *in Siberia.* Hatta, S. 1901.1. — *in Cayuga lake, N. Y.* Meek, S. E. 1886.1; Surface, H. A. 1898.1. — *at Ann Arbor, Michigan.* Schaffner, D. C. 1902.1.

Petromyzon. *Natural history, including descriptions, notes, etc.* Bentivoglio, T. 1895.1; Berthier, V. 1908.1; Cederström, G. C. 1862.1; Ferry, L. 1883.1; Frauen, M. 1879.1; Gage, S. H. 1891.1; ★Geisenheyner, L. 1911.1; Gulliver, G. 1870.1; Hilgendorf, F. M. 1890.1; Holland, (Maj.) – 1870.1; Kouliabko, A. 1897.1; Larbalétrier, A. 1898.1; Leonhardt, E. E. 1903.7; Lubosch, W. 1902.1; Moller, A. F. 1897.1; Nau, B. S. 1787.1; Pollen, F. P. 1871.6; Redeke, H. C. 1901.1; Roy, E. 1906.1; Smith, John A. 1863.6; Surface, H. A. 1898.1; Tilden, J. 1815.1; Anon. 391, 432; Blanc, H. Add. 1890.1.

Variations. Hatta, S. 1911.1; Rosmini, O. 1901.1. — *Identity of P. planeri and P. fluviatilis.* Wajgel, L. 1883.1.

Genera found only in southern waters

Geotria. *Natural history.* Berg, C. 1893.1; Dendy, A. & Olliver, M. F. 1902.1; Gray, J. E. 1851.2; Roché, G. 1893.2.

Macrophthalmia. *Natural history, taxonomy, etc.* Dean, B. 1899.7; Plate, L. H. 1897.1; Philippi, R. A. 1865.1; Prometheus. 1899.2; Steuber, N. J. 1905.1.

Mordacia. *Natural history notes.* Gill, T. N. 1893.5, 1895.6; Hall, E. S. 1865.1.

CLASS PISCES
Aquatic craniates with true jaws (Gnathostomes).

SUB-CLASS ELASMOBRANCHII
Gnathostome fishes with cartilaginous skeleton.

Taxonomy and systematic position. — General treatises. ★Hasse, J. C. 1879.1; Jaekel, O. 1891.3. — *Review of Japanese forms.* Jordan, D. S. & Fowler, H. W. 1903.5. — *Australian species.* Ogilby, J. D. 1888.1, 1889.2.

Fossil Elasmobranchii. — Synopsis with geological arrangement. Agassiz, J. L. 1844.1. — *Chronological distribution.* Hay, O. P. 1901.1. — *Taxonomy of fossil forms.* ★Woodward, A. S. 1889.2. — *For Pre-Linnæan references to fossil Elasmobranch teeth see under* Bufonites and Glossopetras *in section on* Palæontology.

ORDER PLEUROPTERYGII
From the Palæozoic

Family Cladoselachidæ

Cladoselache. *Morphology and relationships.* ★Dean, B. 1893.2, 1894.1, 1909.5.

Family Cladodontidae
(Doubtfully admitted here)

Structure and taxonomy. Claypole, E. W. 1893.1, 1895.2,.7; Dollo, L. 1906.1; Traquair, R. H. 1888.3.

ORDER ICHTHYOTOMI
Forms from Upper Palæozoic

Family Pleuracanthidæ

Structure and taxonomy. Davis, J. W. 1893.1; Fürbringer, K. 1904.1; Jaekel, O. 1891.1, 1895.2; ★Reis, O. M. **1897.1,** 1914.1; Woodward, A. S. 1893.2.

ORDER ACANTHODEI

Range, Upper Silurian to Lower Permian

Skeleton. Dean, B. 1907.2; Reis, O. M. 1890.1, 1894.3.

Taxonomy and relationships. Dames, W. B. 1892.1; ★Dean, B. 1907.2; Dollo, L. 1906.1; Eastman, C. R. 1902.7; Reis, O. M. 1892.2; Woodward, A. S. 1889.2.

Family Acanthodidæ

Morphology and classification. Davis, J. W. 1894.1; Emery, C. 1897.2. — *In Permian of Bohemia.* ★Fritsch, A. J. 1883.1.

Acanthodes. *Morphology and taxonomy.* Jaekel, O. 1899.3, 1899.4; ★Reis, O. M. 1894.1, 1895.1, **1896.1**.

ORDER PLAGIOSTOMI

Including fossil and recent forms

For sharks and rays in fresh-water, see under Physiology.

Relationship to Ganoids. Baird, S. F. 1871.36.

Fossil forms. — *Italian specimens.* Lioy, P. 1865.2. — *General popular account.* Woodward, A. S. 1884.1. — *Plagiostome teeth from English Eocene.* Woodward, A. S. 1900.5.

Taxonomy. — *General treatises.* ★Garman, S. **1913.1**; ★Müller, J. & Henle, F. G. 1837.1–1841.1. — *Synoptic table.* Gracianov, V. I. 1907.2. — *Value in classification of number and position of gill slits.* Jaekel, O. 1890.1.

Taxonomy, forms from — *Indian Archipelago.* Bleeker, P. 1852.11. — *Pacific Ocean.* Miklukho-Maklai, N. N. & Macleay, W. 1879.1. — *Japan.* Pietschmann, V. 1908.3,.5. — *Beaufort, North Carolina.* Radcliffe, L. 1916.1.

SUB-ORDER SELACHII

Sharks

General article, Encyclopedia Britannica. Günther, A. C. 1911.1; Kerr, J. G. 1911.1.

Geographical distribution. Engelhardt, R. 1913.1; Simroth, H. R. 1907.2.

Natural history notes, descriptions, etc. Clarke, S. C. 1877.2, 1880.1; Eichwald, C. E. 1819.1; Gudger, E. W. 1913.1; H., L. 1876.1; ★Hill, R. 1851.1; Moseley, H. N. 1879.1; ★Nichols, J. T. & Murphy, R. C. (*Long Island, N. Y.*) 1916.1; Southwick, J. M. 1885.1; Tatham, W. 1803.1; Anon. 278, 475; Colnett, J. Add. 1798.1. — *Abundance in tropical seas.* Distant, W. L. 1897.1. — *Unusual abundance of dogfish in Scottish waters.* Harvie-Brown, J. A. 1883.1. — *Tenacity of life.* Kemp-Welch, E. B. 1875.1.

Phylogeny and relationships. Dean, B. 1895.5, 1896.11; Woodward, A. S. 1895.8.

Taxonomy. — *General accounts.* Bonaparte, C. L. 1838.2; Fowler, H. W. 1908.2; Gill, T. N. 1858.1; Pavesi, P. 1874.1, 1878.1; ★Regan, C. T. 1906.1. — *Selachii admitted as a class.* Agassiz, J. L. R. 1856.7; Gill, T. N. 1909.4; Poche, F. 1902.1, 1911.1.

Taxonomy of sharks from — *Portugal.* Bocage, J. V. & Capello, F. 1866.1. — *Eastern North America.* Gill, T. N. 1865.12. — *California.* Gill, T. N. 1863.15. — *Chili.* Philippi, R. A. 1887.2, 1902.1. — *Japan.* Pietschmann, V. 1908.3,.5. — *Collection of Musée Océanographique, Monaco.* Roule, L. 1912.2. — *Greenland.* Jensen, A. S. Add. 1914.1.

Fossil forms. Braus, H. 1902.1; Woodward, A. S. 1888.16. — *France.* Joleaud, L. 1905.2. — *Silurian of Oesel I., Russia.* Rohon, J. V. 1893.1. — *Carboniferous of Great Britain.* ★Davis, J. W. 1883.1; Traquair, R. H. 1888.3. — *Triassic of Lorraine.* Jaekel, O. 1889.1. — *Jurassic of Normandy.* Bigot, A. 1897.1; Bigot, A. & Brasil, L. 1904.1. — *Jurassic of Württemberg.* Fraas, E. 1896.1. — *Cretaceous.* Kiprijanoff, V. A. (*Russia*) 1852.1; Woodward, A. S. (*British*) 1894.4. — *Tertiary.* Chapman, F. R. & Pritchard, G. B. (*Australia and New Zealand*) 1904.1; Koch, A. (*Hungary*) 1903.1, 1904.2, 1904.3; Pasquale, M. (*Italy*) 1903.1, 1905.2; Winkler, T. C. (*Belgium*) 1874.1, 1878.2. — *Eocene.* Jaekel, O. (*Monte Bolca*) 1894.1; Stromer, E. (*Egypt*) 1905.1. — *Oligocene of Germany.* Jaekel, O. 1898.4. — *Miocene of California.* Jordan, D. S. & Beal, C. H. 1913.1.

Family Notidanidæ

Six and seven-gilled Sharks

Taxonomy, — *in relation to embryology.* Braus, H. 1906.4. — *of Australian species.* Ogilby, J. D. 1889.2.

Notidanus (**Hexanchus, Heptanchus, Heptranchias,** *syns.*). *Natural history notes, descriptions, etc.* Bellotti, C. 1878.1; Delfortrie, E. 1878.1; Diaz y Martinez, E. 1910.1; Garman, S. 1884.2,.6; Laboissière, V. 1910.1; Macleay, W. 1880.2; Regan, C. T. 1905.10.

Occurrence — *on Scottish coast.* Anderson, W. 1894.1; Traquair, R. H. 1896.3. — *on English coast.* Couch, J. 1846.1, 1851.1; Gray, J. E. 1868.2. — *in California waters.* Jordan, D. S. & Gilbert, C. H. 1880.16. — *Hexanchus in Argentina.* Lahille, F. 1913.1. — *in Irish waters.* Scharff, R. F. 1915.2. — *in Gulf of Gascony.* Vaillant, L. L. 1901.1.

Fossil forms, Notidanus, — *from Italy.* Bassani, F. 1901.1; Sismonda, E. 1861.1; Lawley, R. (*Pliocene of Tuscany*) 1878.3, 1880.1. — *from Miocene, United States.* Cope, E. D. 1867.1. — *from Aptian Cretaceous of France.* Pictet, F. J. 1865.1. — *in British Jurassic.* Woodward, A. S. 1893.6. — *General account.* Woodward, A. S. 1886.2.

Family Chlamydoselachidæ

Chlamydoselachus (*Frilled Shark*). *Natural history.* — *Oldest living type of vertebrate.* Cope, E. D. 1883.7, 1884.8; ★Garman, S. 1884.1,.2, 1884.3,.4,.5; Owston, A. 1903.1; Palmén, J. A. 1900.2.

Occurrence — *at Funchal, Madeira.* Collett, R. 1890.1. — *in Norway.* ★Collett, R. 1897.4, **1903.2**; Grieg, J. A. 1897.3.

— *in Pliocene of Tuscany.* Davis, J. W. 1887.1. — *in Gulf of Gascony.* Pellegrin, J. & Loppé, E. 1914.1.

Taxonomy of Chlamydoselachus anguineus. Davis, J. W. 1885.2; Gill, T. N. Add. 1884.3.

Family Heterodontidæ

(Cestraciodontidæ) Bullhead Sharks

Phylogeny. Eastman, C. R. 1902.6,.7.

Taxonomy — Australian forms. De Vis, C. W. 1911.1; Ogilby, J. D. 1889.2. — *Synopsis.* Regan, C. T. 1908.21.

Fossil forms, structure and taxonomy. — *Carboniferous forms.* Davis, J. W. (*Great Britain*) 1879.2; Lohest, M. (*Belgium*) 1883.1. — *Tertiary, of France.* Delfortrie, E. 1871.1. — *Cretaceous.* Mackie, S. J. 1863.1; Woodward, A. S. 1891.3.

Heterodontus (Cestracion). *Natural history and relationships.* Elliott, S. 1858.1; Nies, F. 1873.1, 1874.1.

Fossil forms. — *Fossil teeth.* Bryant, H. C. 1914.1; Eastman, C. R. 1911.3. — *H. philippii, description and relations of fossil species.* Strüver, J. K. T. 1864.1.

Hybodus (*fossil form from Triassic and Cretaceous*). — *Structure and relationships.* Brown, C. 1900.1; Fraas, E. 1889.1, 1896.1; Koken, E. 1907.1; Lomas, J. 1904.1. — *Reconstruction.* Jaekel, O. 1906.2.

Family Cochliodontidæ

Forms from the Palæozoic

Fossil remains and taxonomy. — *In Carboniferous of Belgium.* Leriche, M. 1908.7. — *Structure of mandibular teeth.* Owen, R. 1867.3,.4. — *Taxonomy.* St. John, O. H. & Worthen, A. H. (*Revision*) 1883.1; Traquair, R. H. 1888.3.

Helodus. — *In Triassic of Alberta.* Lambe, L. M. 1913.2. — *Morphology.* Pander, C. H. 1858.1.

Family Edestidæ

Palæozoic Sharks

Nature and taxonomy. Karpinskiĭ, A. P. 1899.1–1916.1; Woodward, A. S. 1899.5.

Edestus. *Literature of Edestus.* Eastman, C. R. 1903.4, 1905.3.

Occurrence in Carboniferous — *of Illinois.* Newberry, J. S. 1888.4; Newberry, J. S. & Worthen, A. H. 1870.1. — *of Britain.* Newton, E. T. 1904.1; Woodward, A. S. 1916.2. — *of Australia.* Woodward, H. 1886.1.

Structure and taxonomy. Davies, W. 1886.1; Dean, B. 1897.3; Eastman, C. R. 1901.3, 1902.7, 1902.8, 1903.4; Fuchs, T. 1900.1; Hay, O. P. 1909.1, 1912.1; Hitchcock, E. H. 1855.1; Hitchcock, F. R. 1887.1; Leidy, J. 1857.5; Missuna, A. 1907.1; Newberry, J. S. 1884.2, 1888.4; St. John, O. H. 1902.1; Trautschold, H. 1883.1, 1886.1, 1888.1; Wiele, C. 1899.1; Woodward, A. S. 1888.5; Cope, E. D. Add. 1886.2.

Helicoprion. *Occurrence in — Permian of India.* Koken, E. 1901.1. — *Fusulina-limestone of Japan.* Yabe, H. 1903.1.

Structure of helicoidal organ and relationship of Helicoprion. Eastman, C. R. 1900.4, 1901.3; Fuchs, T. 1900.1; Hay, O. P. 1909.1; Jaekel, O. 1900.1; ★Karpinskiĭ, A. P. 1899.1–1916.1; Klaatsch, H. 1901.1; Priem, F. 1900.1; Wiele, C. 1899.1; Woodward, A. S. 1899.5, 1900.3.

Family Psammodontidæ

Carboniferous Sharks

Taxonomy, revision. St. John, O. H. & Worthen, A. H. 1883.1.

Family Petalodontidæ

Carboniferous and Permian

Morphology and relationships. Jaekel, O. 1899.2; Traquair, R. H. 1888.3.

Family Scylliidæ

Dogfishes

Taxonomy. Duméril, A. H. 1853.1,.2.

Ginglymostoma (*Nurse Shark*). — *Natural history.* Gudger, E. W. 1913.5, Add. 1912.2, 1914.2. *For fullest data on the natural history see* E. W. Gudger *in* Copeia, 1921, *pp.* 57–59.

In Eocene of Sicily. Gemmellaro, M. 1912.2.

Pseudotriakis. *Occurrence* (*only known specimens*) — *on coast of Long Island.* Bean, T. H. 1884.5; Baird, S. F. Add. 1884.1. — *off Portugal.* Capello, F. 1868.2,.3.

Sub-family Hemiscylliinæ

Taxonomy; Philippine Archipelago. Smith, H. M. 1913.2.

Sub-family Orectolobinæ

Nomenclature. Gill, T. N. 1896.12.

Taxonomy; revision. Ogilby, J. D. & McCulloch, A. R. (*Australian species*) 1908.1; Regan, C. T. 1908.19.

Sub-family Scylliorhininæ

Taxonomy; synopsis. Regan, C. T. 1908.22.

Family Carchariidæ

Carcharias. *Fossil species from — Pliocene of Spain.* Binney, E. W. 1879.1. — *Red Crag of Suffolk.* Charlesworth, E. 1837.1. — *South Carolina.* Manigault, G. E. 1886.1.

Galeocerdo (*Tiger Shark*). — *Comparison, living and fossil forms.* Lawley, R. 1881.1.

Fossil species from — Miocene; United States. Cope, E. D. 1867.1. — *Piedmont, Italy.* Sismonda, E. 1861.1. — *English Chalk.* Woodward, A. S. 1894.2.

Mustelus. *Differences between the two European forms.* Pietschmann, V. 1908.4.

Prionodon. *Taxonomy; general account.* Carruccio, A. 1912.2.

Thalassorhinus. *Original description.* Walbaum, J. J. 1784.2.

Family Lamnidæ

Mackerel Sharks

Fossil teeth in — Italian Tertiary deposits. Oppenheim, P. 1901.1. *— Eocene of Rumania.* Popovici-Hatzeg, V. 1896.1. *— Eocene of Egypt.* Quaas, A. 1902.1.

Alopias (**Alopecias**) (*Thresher or Fox Shark*). *Natural history, occurrence, etc.* Clogg, S. 1881.1; Couch, R. Q. 1864.4; Gatcombe, J. 1882.1, Add. 1885.2; Grieg, J. A. 1902.1; Johnston, G. 1849.1; Mitchill, S. L. 1805.2; Parona, C. 1883.1; Pascoe, F. P. Add. 1881.1; Southwell, E. Add. 1906.1.

Carcharodon (*Man-eater*). *— Occurrence — in Italian and Sicilian waters.* Facciolà, L. 1894.1; Riggio, G. 1894.1; Sanzo, L. 1910.1. *— off coast of California.* Holder, C. F. 1900.2. *— Nantucket, Mass.* Stevenson, W. G. 1884.1.

Fossil forms — from Italy. Bassani, F. 1877.1, 1886.3, 1895.2. *— in Cretaceous of California.* Blake, J. H. 1873.1. *— in Pliocene of Belgium.* Dewalque, G. 1864.1, 1871.1. *— in Spitzbergen.* Hansemann, D. 1910.1. *— in Oligocene of Panama.* Joukowsky, E. 1906.1. *— in South Carolina.* Manigault, G. E. 1886.1. *— in Tertiary of Chile.* Möricke, W. 1895.1; Philippi, R. A. 1878.1. *— in Oligocene of Helmstedt.* Nehring, A. 1878.1.

Restoration of jaws of C. megalodon. Dean, B. 1909.1; Hussakof, L. 1912.2.

Lamna (*Porbeagle*). *Natural history notes.* Goodenough, S. 1797.1; Mayer, A. F. 1842.2; Weber, M. C. 1892.1; Clément, C. Add. 1876.1.

Occurrence — on English coast. Bowerbank, J. S. 1873.2, 1874.1; Gatcombe, J. 1881.1; Kermode, P. M. 1897.2; Thompson, W. 1850.2. *— off Scottish coast.* Campbell, J. M. 1880.1; Evans, W. 1905.1; Taylor, W. 1910.1. *— on coast of Friesland.* Ehlers, E. H. 1886.1. *— in New Zealand.* Haast, J. F. 1875.1. *— in Irish waters.* Warren, R. 1900.2. *— in Dublin Bay.* Duerden, J. E. Add. 1894.1.

Mitsukurina (**Scapanorhynchus**). *Natural history, including descriptions, occurrence in Japanese waters, taxonomy, etc.* Bean, B. A. 1905.3; Dean, B. 1903.1; Engelhardt, R. 1912.1; Hussakof, L. 1909.1, 1910.3; Jordan, D. S. 1898.2; Stehli, G. 1912.2; Vaillant, L. L. 1904.4; Woodward, A. S. 1899.3.

Odontaspis. *Occurrence at Sardinia.* Carruccio, A. 1910.1.

Oxyrhina. *— General treatise.* ★Eastman, C. R. **1894.1.** *— O. hastalis, in Miocene of Italy.* Alessandri, G. 1896.1.

Family Cetorhinidæ

Cetorhinus (**Selache**) (*Basking Shark*). *Natural history.* Baird, S. F. 1868.1, 1874.2; Giglioli, E. H. 1877.1; Gunner, J. E. (*Original description*) 1767.1; Lehmann, M. C. 1803.1; Vieira, L. 1894.4; Wright, E. P. 1876.1.

Occurrence in western Atlantic — in Bay of Fundy. Foulis, R. 1852.1. *— off Newfoundland.* Harvey, M. 1877.1, 1880.1. *— off Long I., N. Y.* Hussakof, L. 1915.1.

Occurrence on Scandinavian and Iceland coasts. — Norwegian waters. Collett, R. 1903.2; Grieg, J. A. 1897.1; Friis, N. C. Add. 1772.1, Add. 1776.1. *— Iceland.* Lütken, C. F. 1879.1, 1880.2; Sæmundsson, B. 1897.1.

Occurrence on British coast. — Cornwall. Cornish, T. 1870.4, 1885.1; Gatcombe, J. Add. 1885.1. *— Scotland.* Elmhirst, R. 1913.1; Murie, J. Add. 1906.1. *— Isle of Wight.* Hadfield, H. 1875.1. *— Torquay harbour.* Pengelly, W. 1891.1. *— in Irish waters.* Scharff, R. F. 1915.2.

Occurrence off Spain and Portugal. Capello, F. 1870.4; Escribano, C. 1909.1.

Occurrence on Italian coast. Carazzi, D. 1904.3; Carruccio, A. 1906.1, 1907.1; Damiani, G. 1903.1; Mazzarelli, G. F. 1908.2; Monti, R. 1910.1; Parisi, B. 1912.1; Parona, C. 1908.1; Pavesi, P. 1874.1, 1877.1; Senna, A. 1913.1.

Occurrence in the Pacific. Bennett, F. D. 1840.1; Wilson, E. R. 1877.1. *— in Australian and New Zealand waters.* Cheeseman, T. F. 1891.1; Kershaw, J. A. 1902.1; Beneden, P. J. Add. 1893.1; Macleay, W. J. Add. 1884.1. *— For a general account of Cetorhinus in the southern Hemisphere, see* E. W. Gudger *in* Science, 1915, n.s. *vol.* 42, *pp.* 653–656.

Taxonomy and synonymy. Blainville, H. M. 1810.1; Couch, J. 1864.2; Pavesi, P. 1874.1.

Fossil forms. — in Pliocene of Belgium. Hasse, J. C. 1879.1. *— in Pliocene of Ricava, Tuscany.* Lawley, R. 1880.2. *— in Miocene of San Marino Republic.* Lawley, R. 1882.1.

Family Rhinodontidæ

Rhineodon (*Whale Shark*). *— Natural history.* ★Bean, B. A. **1905.2**. *— Discovery — first description, anatomy, earliest figure, etc.* Smith, A. 1829.1, 1849.1.

For a paper reviewing previous literature on habits, anatomy, etc., with reproductions of every known figure, and a collection of records of occurrence, see Gudger, E. W. 1915.1. *For "Further notes on habits and distribution," see his article in* Science, 1918, n.s. *vol.* 48, *pp.* 622–627.

Family Spinacidæ

Spiny Sharks

Taxonomy in relation to embryology. Braus, H. 1906.4.

Centrina. *Natural history.* Künstler, J. & Chaine, J. 1906.2.

Centrophorus. *Natural history notes.* Jensen, A. S. 1899.1; Bocage, J. V. Add. 1872.1.

Occurrence — off Madeira Islands. Lowe, R. T. 1852.1. *— in Irish waters.* Scharff, R. F. 1915.2. *— in British waters.* Sim, G. 1902.2.

Echinorhinus. *Occurrence — on coast*

of Cornwall. Cornish, T. 1866.4, 1870.7, 1875.2, 1882.3. — *on British coast.* Gray, J. E. 1868.2. — *on Dublin coast.* More, A. G. 1882.1. — *at Venice.* Ninni, E. 1904.2. — *in New Zealand waters.* Parker, T. J. 1884.4.

Læmargus (Somniosus) (*Sleeper Shark, Greenland Shark*). *Natural history notes, descriptions, etc.* Gunner, J. E. (*Earliest description*) 1766.3; Levander, K. M. 1898.1; Möbius, K. A. 1890.1; Rosted, E. 1788.1; Trail, J. 1872.1; Valenciennes, A. 1832.1.

Occurrence — on coast of Netherlands. Beaufort, L. F. 1911.1. — *on coast of Scotland.* Brown, R. 1860.1. — *on Dogger Bank.* Cordeaux, J. 1866.1. — *in Danish waters.* Fiedler, H. V. 1866.1. — *on coast of Italy.* Sicher, E. 1898.1. — *off Suffolk coast.* Southwell, T. 1875.1. — *in lower St. Lawrence.* Dawson, J. W. Add. 1891.1.

Scymnus. *Nomenclature.* Gill, T. N. 1896.14.

Family Squalidæ

Taxonomy. — Chile. Pérez, C. C. 1886.1. — *Philippines.* Smith, H. M. 1912.6. — *Synopsis.* Regan, C. T. 1908.23.

Fossil forms. — Monograph, fossil forms of United States. Gibbes, R. W. 1847.1, 1848.2. — *Miocene of California.* Leriche, M. 1908.4. — *Eocene of Egypt.* Stromer, E. 1905.1.

Family Pristiophoridæ

Systematic position and fossil remains. Jaekel, O. Add. 1890.3.

SUB-ORDER BATOIDEI

Rays

Natural history notes, popular articles, etc. Clarke, S. C. 1880.3; Fowler, H. W. 1910.6; Müller, J. 1839.3; Roberts, A. W. 1880.1; Schneider, J. G. 1788.1.

Taxonomy and relationships. Jaekel, O. 1898.1. — *Indian forms.* Annandale, N. 1909.1, 1910.1. — *Relationship with sharks.* Hasse, J. C. 1877.2.

Family Pristidæ

Fossil forms from Eocene of Egypt. Stromer, E. 1905.1.

Pristis (*Saw-fish*). — *Natural history data.* Caton, J. D. 1879.1; Guettard, J. E. 1768.1; Latham, J. (*First scientific description*) 1794.1; Pappenheim, P. 1905.1; Rawlinson, T. E. 1858.1; Southwell, T. 1902.3; Perrault, C. Pre-Linn. 1733.1. — *Taxonomy, synopsis of fossil species.* Vigliarolo, G. 1891.1.

Propristis. *Occurrence — in Eocene of Egypt.* Fraas, E. 1907.1. — *in lower Tertiary of Egypt.* Priem, F. 1897.1.

Family Rhinobatidæ

Guitar fishes

Taxonomy; synopsis American species. Garman, S. 1880.1.

Family Raiidæ

Skates and Rays

Taxonomy. Delfin, F. T. 1902.2; Garman, S. (*United States*) 1875.1; Jaekel, O. 1898.1. — *From Eocene of Monte Bolca.* Molin, R. 1861.1.

Raia. *Natural history accounts, descriptions, etc.* Batarra, G. 1765.1; Beneden, E. 1894.1; Borcéa, J. 1907.2, .3; Giorna, M. E. 1805.1; Harting, P. 1867.4; Schneider, J. G. 1783.2; Calderwood, W. L. Add. 1892.1; Günther, A. C. (*Encyc. article*) Add. 1866.1; Columna, F. Pre-Linn. 1592.1.

Genera Hieroptera and Propterygia. *Originally described as specific forms, these are now known to be rays with arrested development of the pectorals* (*these nonadherent to the head*). *For such see under* Abnormalities of Fins, *in section on* Teratology.

Family Torpedinidæ

Electric Rays

For anatomy and function of electrical organs, see under Electrical Fishes.

General treatise. Duméril, A. H. 1852.1. — *Synonymy.* Gill, T. N. 1896.15. — *Natural history.* Kammerer, P. 1906.1.

Genus Torpedo. — *Natural history.* Basarow, A. 1877.1; Bonaparte, C. L. 1840.2; Bouvier, E. L. 1890.2; Bryant, W. 1786.1; Colladon, L. T. 1836.1; ★Fulton, T. W. 1901.1; Grisellini, F. 1764.1; Harting, P. 1880.2; Le Juge, E. 1876.1; Linck, J. W. 1788.1; Lucchesini, - 1783.1; Montelimart, D. F. 1799.1; ★Olfers, I. F. 1831.1; Poche, F. 1907.2; Langguth, G. A. Add. 1779.1; Schilling, G. W. Add. 1770.1. — *Fossil form, Torpedo hilgendorfi, in Tertiary of Kamerun.* Jaekel, O. 1904.3.

Family Trygonidæ (Dasyatidæ)

"Stingarees" or Sting Rays

Dasybatus. — *Taxonomy. Synopsis, American species.* Garman, S. 1882.1. — *Nomenclature.* Garman, S. 1885.3.

Family Myliobatidæ

Eagle Rays

Nomenclature. Gill, T. N. 1895.5.

Fossil forms — in Sicily. Salinas, E. 1901.1. — *in Eocene of Bavaria.* Stromer, E. 1904.2. — *in Eocene of Egypt.* Stromer, E. 1905.1.

Aëtobatus (*Spotted Sting Ray*). — *Nomenclature.* Gill, T. N. 1895.5. — *Fossil forms.* Castro, M. F. (*Tertiary, Cuba*) 1873.1; Cope, E. D. (*Miocene, United States*) 1867.1; Sloane, H. (*Maryland*) Pre-Linn. 1697.1.

For a paper reviewing all previous literature on habits, coloration, external structures, distribution, reproduction, with many illustrations original and reproduced, and with a full synonymy, see Gudger, E. W. 1914.1.

Dicerobatis. *Natural history, occurrence, etc., — in Jamaica.* Hill, R. 1863.1.

— *on coast of Natal.* Millar, A. D. 1899.1. — *in Oran.* Pellegrin, J. 1901.6. — *in the Mediterranean.* Pellegrin, J. 1902.3. — *at Funchal, Madeira.* Vinciguerra, D. 1883.1.

Ceratoptera. *Occurrence and natural history — at Port Royal, Jamaica.* Lamont, A. 1824.1.

Cephaloptera. *Natural history.* Heeckeren Tot Waliën, L. 1897.1; Vorderman, A. G. 1897.1.

Occurrence — in Jamaica. Bancroft, E. N. 1829.1. — *at Malta.* Gulia, Giovanni. 1909.3. — *in the Mediterranean.* Pellegrin, J. 1902.3. — *in Irish waters.* Thompson, W. 1835.1, 1837.1. — *in Straits of Messina.* Facciolà, L. Add. 1903.1. — *at Cette.* Ribart. Add. 1759.1.

Manta (*Devil fish*). *Natural history.* ★Elliott, W. 1846.1–1867.1; ★Gill, T. N. **1908.5**; H., C. F. 1874.2; Holder, C. F. 1899.1; Holder, J. B. 1871.1; Holmes, F. S. 1856.1; Lesueur, C. A. 1824.1; Mitchill, S. L. 1824.1; Pellegrin, J. 1900.8; Anon. 308, 309.

Occurrence — on coast of Peru. Baer, G. A. 1899.1; Vaillant, L. L. 1899.2. — *on California coast.* Diguet, L. 1898.1; Kahilainen, W. 1899.3; Oustalet, E. 1899.1; Pellegrin, J. 1901.5,.6; Vaillant, L. L. & Diguet, L. 1898.1; Newman, E. Add. 1849.1. — *on New Jersey coast.* Fowler, H. W. 1903.8. — *in Mediterranean.* Pellegrin, J. 1902.3. — *in North Carolina.* Gill, T. N. Add. 1903.2.

Myliobatis (*Eagle Ray*). *Natural history.* Johnston, G. 1834.3; Cunningham, J. T. Add. 1895.3; Holt, E. W. & Garstang, W. Add. 1898.1.

Fossil forms. Taxonomy and occurrence. Gibbes, R. W. 1847.2; Marsh, O. C. 1870.1; Owen, R. 1847.1; Philippi, R. A. 1846.1. — *In Eocene.* Delheid, E. (*Belgium*) 1896.2; Popovici-Hatzeg, V. (*Rumania*) 1896.1; Woodward, A. S. (*England*) 1888.9. — *In Tertiary:* Kissling, E. (*Switzerland*) 1902.2; Meyer, C. E. H. (*Germany*) 1851.2; Woodward, A. S. (*Egypt*) 1893.8. — *Cretaceous, Tunis.* Sauvage, H. E. 1889.2.

Mobula (*Small Devil-fish*). *Natural history and occurrence — off the North Carolina coast.* Boulenger, G. A. 1912.9; Pellegrin, J. 1912.4. — *in Javanese waters.* Kampen, P. N. 1910.1.

Ptychodus. *Dentition.* Canestrelli, G. 1910.1; Woodward, A. S. 1887.6.

ORDER HOLOCEPHALI

Taxonomy of fossil forms. ★Woodward, A. S. 1889.2.

Family Ptyctodontidæ

Devonian forms

Arthrodiran affinities. Dollo, L. 1907.2. — *Dentition.* Eastman, C. R. 1898.2, 1904.8.

Ptyctodus. *Morphology (particularly dentition) and relationships.* Pander, C. H. 1858.1; Rohon, J. V. 1895.1.

Family Squaloraiidæ

Lias

Squaloraia. *Structure and affinities.* Howes, G. B. 1890.1; Weyl, T. 1884.1; Woodward, A. S. 1886.1.

Family Myriacanthidæ

Lias

Taxonomy. Woodward, A. S. 1889.9.

Family Chimæridæ

Including fossil and recent forms

General treatises, recent forms. — Chimæroid fishes and their development. ★Dean, B. **1906.1**. — *Origin of Chimæridæ.* Regan, C. T. 1912.14.

Taxonomy of recent forms. Bean, B. A. & Weed, A. C. 1910.1; ★Garman, S. 1901.1, **1904.1, 1911.1**. — *in Irish waters.* Holt, E. W. L. & Byrne, L. W. 1910.3. — *in Philippines.* Smith, H. M. 1912.2.

Fossil forms, structure and taxonomy. General accounts. — Taxonomy. Egerton, P. G. 1843.2, 1846.1, 1847.2; Riess, J. A. 1887.1.

Occurrence of fossil forms — in Jurassic of Württemberg. Fraas, E. 1896.1. — *in Jurassic of Prussia.* Meyer, C. E. H. 1859.3. — *in American Cretaceous.* Hussakof, L. 1912.1. — *in British Cretaceous.* Newton, E. T. 1878.1, 1880.1, Add. 1878.1. — *in Cretaceous of New Zealand.* Newton, E. T. 1877.1.

Callorhynchus. *Earliest known figure.* Frézier, A. F. Pre-Linn. 1716.1.

Chimæra. *Natural history accounts.* Baird, S. F. 1877.2; Dean, B. 1904.6; Gunner, J. E. 1766.7; L., W. N. 1879.1; Holt, E. W. Add. 1893.1.

Occurrence — at Nice. Deakin, R. 1866.1. — *in North Sea.* Cordeaux, J. Add. 1898.1. — *in California waters.* Serre, P. 1901.1.

Phylogeny and relationships. Dean, B. 1899.5, 1905.3.

Taxonomy. — Philippine species. Smith, H. M. 1912.2. — *Japanese species.* Tanaka, S. 1905.1,.2. — *Cuban species.* Poey y Aloy, F. 1865.1.

Fossil forms — in Cretaceous of England. Buckland, W. 1836.1. — *in Jurassic of Bavaria.* Meyer, C. E. 1863.1. — *Synopsis of fossil species.* Egerton, P. G. 1843.2.

Harriotta. *Natural history.* Dean, B. 1904.8; Mitsukuri, K. 1905.1.

SUB-CLASS TELEOSTOMI

Gnathostome fishes with bony skeleton.

Phylogeny. Regan, C. T. 1904.9.

Fossil forms. — Of Florissant (Colorado) shales. Cockerell, T. D. 1906.1, 1908.2. — *Eocene of Wyoming.* Cope, E. D. 1873.3. — *Taxonomy of fossil forms.* Woodward, A. S. 1889.2.

SERIES GANOIDEI

(Formerly a sub-class)

This group name is retained here for convenience, as it has been in other parts of the Subject Index, and under it are included various fossil orders, families, and genera, and the recent orders Crossopterygii, Chondrostei, and Holostei with their genera.

Phylogeny and relationships. — *General treatises.* ★Müller, J. **1844.2**, 1845.1, 1846.1,.2; Orr, H. 1885.1. — *Relation to Plagiostomes.* Baird, S. F. 1871.36. — *Relations with Teleosts.* Huxley, T. H. 1883.2. — *Relation to Clupeidæ.* Stannius, F. H. 1846.1. — *Affinities in general.* Dean, B. 1895.6,.7; Zograf, N. Y. 1887.4.

Taxonomy, general accounts. Agassiz, J. L. R. 1856.9; Baird, S. F. 1871.28; Fowler, H. W. 1910.7; Hollard, H. L. 1850.1; Kner, R. 1866.1; ★Lütken, C. F. 1868.1, 1869.1,.2, 1871.1, 1873.1,.4; Vogt, C. C. 1845.1.

Fossil forms. General papers. — *Synopsis of fossil forms.* Agassiz, J. L. 1833.3, 1835.1. — *Geological history.* Bachmann, I. 1877.1. — *Ganoidei heterocerci.* Egerton, P. G. 1848.3 (3). — *Palæontology.* Martin, Carl. 1873.1. — *Devonian forms.* Pander, C. H. 1860.1. — *On the genera of Agassiz.* Traquair, R. H. 1877.3. — *Charts illustrative of.* Zittel, K. A. 1900.1.

Occurrence of fossil forms in — *Illinois, Ohio and Pennsylvania.* Cope, E. D. 1897.2. — *Fayum, Egypt.* Dames, W. B. 1883.1. — *Trias of Germany.* Dames, W. B. 1888.2; Deecke, J. E. 1889.1. — *Carboniferous, England.* Davis, J. W. 1871.1; Miall, L. C. 1872.1, 1879.1. — *Deccan, India.* Egerton, P. M. 1878.1. — *Trias of Connecticut Valley.* Lull, R. S. 1912.1, 1915.1. — *Carboniferous of France.* Sauvage, H. E. 1889.1. — *Silurian of Oesel I., Russia.* Rohon, J. V. 1893.1. — *Eocene of Egypt.* Stromer, E. 1905.1. — *Lithographic limestone, Munich Museum.* Vetter, B. 1881.1. — *Jurassic of Bavaria.* Wagner, J. A. 1863.1. — *English Lias.* Woodward, A. S. 1890.5. — *English Greensand; synopsis.* 1895.9.

ORDER CROSSOPTERYGII

Fossil and recent

Recent Crossopterygii. — *Revision; African species.* Boulenger, G. A. Add. 1909.1.

Structure and relationships of fossil forms. Cope, E. D. 1891.3,.4; Huxley, T. H. 1866.1; Miall, L. C. 1878.1; Pander, C. H. 1860.1; Watson, D. M. & Day, H. 1916.1. ★Woodward, A. S. **1889.2.**

SUB-ORDER OSTEOLEPIDA

Devonian and Carboniferous forms, one family, Cœlacanthidæ, persisting into the Cretaceous.

Family Osteolepidæ

Megalichthys. *Structure and systematic position.* Watson, D. M. 1912.1; Wellburn, E. D. 1900.3.

Family Rhizodontidæ

Eusthenopteron. — *For a recent summary of our knowledge of Eusthenopteron, see* ★W. L. Bryant, *in* Bull. Buffalo Soc. Nat. Sci., 1919, *vol.* 13, *pp.* 1–22, 18 *pls.*

Family Holoptychidæ

Dendrodontidæ, synonym

Structure. — *Dentition.* Jaekel, O. 1894.3; Pander, C. H. 1860.1. — *Forms in Russian Devonian.* Rohon, J. V. 1889.1. — *Scales in Russia.* Rohon, J. V. 1892.1.

Systematic position. Traquair, R. H. 1889.4; Trautschold, H. 1889.2.

Family Cœlacanthidæ

Structure and taxonomy. ★Reis, O. M. 1888.1. — *Osteology.* 1892.3. — *Restoration of Cœlacanthus.* Wellburn, E. D. 1902.2.

SUB-ORDER CLADISTIA

Family Polypteridæ

No fossil forms

For maps showing the distribution of the Polypteridæ, see Bridge, T. W. 1904.1 (*p.* 483), *and* Meek, A. 1916.1 (*p.* 57).

Calamoichthys. *Natural history.* Gervais, F. L. 1867.1; Smith, John A. 1867.1,.2,.11.

Polypterus. *Natural history.* Budgett, J. S. 1900.1,.3, 1907.1; Dean, B. 1899.2; Geoffroy-Saint-Hilaire, E. F. 1802.2,.3; Harrington, N. R. 1899.1,.2.

Taxonomy, phylogenetic position, etc. Ayres, W. O. 1850.2; Boulenger, G. A. 1898.13, 1911.5; Duméril, A. H. A. 1869.1; Goodrich, E. S. 1908.2; Guichenot, A. 1839.1; Pollard, H. B. 1891.1, 1892.2; Steindachner, F. 1869.1,.2. — *Diagnostic key to young.* Boulenger, G. A. 1902.27. — *Differences between the three Nile species.* Steindachner, F. 1882.2.

ORDER CHONDROSTEI

(Acipenseroidei, or cartilaginous Ganoids)

For a map showing the geographical distribution of the recent Chondrostei, see Meek, A. 1916.1 (*p.* 50).

Structure, taxonomy and affinities of both recent and fossil forms. Heckel, J. J. 1851.5; Woodward, A. S. 1889.2; Zograf, N. Y. 1887.4.

Palæontology, Acipenseroidei. Woodward, A. S. 1889.10.

Family Cheirolepidæ

Devonian

Morphology. Pander, C. H. 1860.1.

Family Palæoniscidæ

Devonian to Jurassic

Occurrence, structure and taxonomy of forms from — *Permian of Bohemia.* Fritsch, A. J. 1883.1. — *Carboniferous of New Brunswick.* Lambe, L. M. 1910.1. — *Trias of British Isles.* Lomas, J. 1904.1. — *Carboniferous of France.* Sauvage, H. E. 1888.3. — *British Carboniferous.* ★Traquair, R. H. 1877.1, 1886.1, 1888.2, 1901.1, 1907.1, 1909.1, 1911.1, 1912.1. — *Ecca shales.* Woodward, A. S. 1910.1.

Family Platysomidæ

Carboniferous and Permian

Structure and affinities. Cope, E. D. 1880.4; Gill, T. N. 1881.3; ★Traquair, R. H. 1879.3, Add. 1880.2.

Family Belonorhynchidæ

Triassic forms, doubtfully Chondrostean

Osteology and taxonomy. Reis, O. M. 1892.4.

Family Catopteridæ

Triassic forms

Taxonomy. Eastman, C. R. 1914.1; Silliman, B. 1821.1.

Family Chondrosteidæ

English Lias

Structure and taxonomy. Woodward, A. S. 1889.2.

Family Polyodontidæ

Crossophilis. *Fossil paddlefish from Eocene of Wyoming.* Cope, E. D. 1883.3, 1885.1, 1886.2.

Polyodon folium (spathula) (*Spoonbill or Paddlefish*). *Natural history and occurrence in Mississippi R. and tributaries.* Allen, W. F. 1911.1; Beach, H. 1902.1; Beard, D. C. 1878.1; Cabot, S. 1848.2; Clemens, J. W. 1827.1; Hildreth, S. P. 1827.1; ★Hussakof, L. 1910.5, 1911.3; Kofoid, C. A. 1900.1; Lacépède, B. G. (*First description*) 1797.1; Mitchill, S., Hildreth, S. & Clemens, J. W. 1822.1; Nichols, J. T. 1916.2; Polk, B. H. 1879.1; Silliman, B. 1827.1; ★Stockard, C. R. 1907.5; Travell, W. 1914.1; Alexander, M. L. Add. 1914.1.

Psephurus gladius (Polyodon (angustifolium) gladius) *from China. Structure and classification.* Duméril, A. H. A. (*Fine figures*) 1868.1; Handyside, P. D. 1875.1; Kaup, J. J. 1862.1; Martens, E. (*Discoverer*) 1862.1.

Family Acipenseridæ

Sturgeons

Taxonomy. Berg, L. S. 1904.1; ★Duméril, A. H. 1867.2, 1868.1. — *European-Asiatic forms.* Brandt, J. F. 1869.1. — *Russian species.* Golowatschow, A. 1857.1; Lovetsky, A. 1834.1. — *European forms.* Heckel, J. J. 1851.3. — *Synopsis; Japanese forms.* Jordan, D. S. & Snyder, J. O. 1906.4. — *Caucasian forms, including those from Caspian and Black Seas.* ★Kavraiskiï, T. T. 1907.1; Sodoffsky, W. 1849.1. — *Review; North American forms.* Kirsch, P. H. & Fordice, M. W. 1890.1. — *Italian forms.* Maglio, C. 1901.1; Nardo, G. D. 1873.2; Pavesi, P. 1907.1.

Fossil forms from Eocene of Paris basin. Priem, F. 1904.3.

Acipenser (*Sturgeon*). *General treatises.* Brusina, S. (*Text in Bohemian*) 1902.1; Heckel, J. J. & Fitzinger, L. J. 1836.1.

Natural history notes. — *Text in English.* Baker, W. 1847.1; Evermann, B. W. 1898.4; Fulton, T. W. 1903.2; Sweetapple, E 1867.2; White, J. H. 1873.1. — *Text in French.* Duchaussoy, H. 1891.1; Roule, L. 1905.3. — *Text in German.* Berg, P. J. 1776.1; ★Ehrenbaum, E. 1896.1, Add. 1913.3; Grimm, O. 1895.1; Kornhuber, G. A. 1901.2,.3,.4; Pallas, P. S. 1776.1; Bergius, B. & Marwitz, Add. 1776.1; Brandt, J. F. & Ratzeburg, J. T. Add. 1831.1. — *Text in Russian.* Borodin, N. A. 1897.1, 1901.2; Grünberg, V. 1905.1; ★Peltzam, E. D. 1883.1. — *Text in Finnish, Bohemian, Swedish, and Polish, respectively.* Kahilainen, W. 1899.1; Katuric, M. 1903.1; Nordqvist, O. F. 1899.1,.3; Schalin, Z. 1883.1; Rozwadowski, J. 1906.1,.2.

A. ruthenus, variation. Mojsisovics von Mojsvar, A. 1892.1.

Fossil forms — *in Cretaceous of Canada.* Lambe, L. M. 1902.1; Osborn, H. F. 1902.1. — *from Palæozoic.* Zittel, K. A. 1886.2.

Scaphirhynchus (*Shovel-nosed Sturgeon*). *Taxonomy.* Pappenheim, P. 1905.4; Westberg, P. 1899.1.

American form, occurrence and taxonomy — in Ohio R. Agassiz, J. L. 1846.2; Heckel, J. J. 1836.2; Gill, T. N. Add. 1863.1.

Asiatic (Turkestan) form of Scaphirhynchus (Pseudoscaphirhynchus and Kessleria, synonyms), natural history, occurrence and taxonomy. Baer, K. E. 1874.1; Baird, S. F. 1873.29; Grevé, C. H. 1896.1; Günther, A. C. 1873.5; Kessler, K. T. (*first account*) 1873.2, 1874.1; Nikolskii, A. M. 1900.2.

Parascaphirhynchus. *P. albus described from nine specimens taken in Mississippi R.* Forbes, S. A. & Richardson, R. E. 1905.1.

ORDER HOLOSTEI

(Lepidosteoidei, or bony Ganoids)

For a map showing the distribution of the recent Holostei, see Meek, A. 1916.1 (*p.* 53).

Family Semionotidæ

Permian to Cretaceous inclusive

Occurrence and taxonomy. — *Triassic, Connecticut R. Valley.* Lull, R. S. 1915.1. Silliman, B. 1821.1. — *General account.* Woodward, A. S. 1895.3.

Dapedius. *Taxonomic revision.* Browne, A. M. 1890.1.

Lepidotus. *Morphology and taxonomy.* ★Branco, C. W. 1885.1, **1887.1**, 1890.1; Priem, F. 1908.2.

Semionotus. *Structure and classification.* Schellwien, E. T. 1902.1.

Family Pycnodontidæ

Lower Lias through Lower Eocene

General treatise. ★Hennig, E. **1906.1**, 1907.2.

Taxonomy and occurrence. Egerton, P. G. 1877.1; Heckel, J. J. 1854.4, 1855.1; Hermann, R. 1907.1; Woodward, A. S. 1893.10. — *In France.* Cornuel, J. (*Paris Basin, Jurassic*) 1880.1, 1883.1; Leriche, M. 1901.2; Priem, F. (*Tertiary*) 1902.1. — *In Jurassic of Switzerland.* Jaccard, S. A. 1888.1. — *In lithographic limestone of Bavaria.* ★Wagner, J. A. 1863.1.

Gyrodus. *Morphology; monographic treatment.* Hennig, E. 1906.1.

Family Eugnathidæ

Triassic and Jurassic

Structure and taxonomy. Woodward, A. S. 1889.2.

Caturus and Osteorachis. *Osteology.* Woodward, A. S. 1897.2.

Family Amiidæ Camiatidæ

Range, Eocene to present

Taxonomy. Hay, O. P. 1898.1.

Amia (*Bow-fin, Grindle*). *Natural history, occurrence, etc.* Bean, T. H. 1890.17; Eyrich, G. C. 1877.1; Desrochers, J. E. 1904.1; Debschitz, H. 1901.2,.5; ★Reighard, J. **1904.2**; Robinson, W. E. 1875.1. — *In Susquehanna R.* Stauffer, J. 1879.1. — *Nomenclature, general discussion.* Heckel, J. J. 1851.5.

Fossil species — in Miocene of Germany. Andreae, A. 1893.1, 1894.1. — *in Tertiary.* Giebel, C. G. (*France*) 1869.1; Marsh, O. C. (*Wyoming*) 1871.1. — *in Oligocene.* Lambe, L. M. (*Saskatchewan*) 1908.1; Leriche, M. (*Isle of Wight*) 1908.6; Newton, E. T. (*Isle of Wight*) 1899.1. — *in Eocene of Suffolk.* Leriche, M. 1907.5.

Amiopsis, *from — Black Hills of South Dakota.* Eastman, C. R. 1900.3. — *Cretaceous of Croatia.* Kner, R. 1863.3.

Family Pachycormidæ

Lias through Cretaceous

Taxonomy. — *Of forms from Jurassic of France.* Sauvage, H. E. 1898.1. — *Characteristics of the genera.* Wagner, J. A. 1860.5.

Protosphyraena (Erisichthe). — *Structure, taxonomy and affinities.* Cope, E. D. (*General account*) 1877.5; Felix, J. P. 1890.1; Hay, O. P. 1902.3, 1903.2; Quaas, A. 1902.1; Steward, A. S. 1898.1; Woodward, A. S. 1894.7.

Occurrence in Cretaceous. — *Kansas Niobrara.* Cope, E. D. 1872.5. — *Italy.* Mariani, E. 1902.1. — *Lincolnshire.* Woodward, A. S. 1912.3. — *Belgium.* Dollo, L. Add. 1893.1.

Family Aspidorhynchidæ

Upper Jurassic and Cretaceous

Evolution. Woodward, A. S. 1890.12.

Aspidorhynchus. *Structure and relationships.* Assmann, P. 1906.1. — *Relation to Lepidosteus.* Reis, O. M. Add. 1888.1.

Family Lepidosteidæ

Classification. Hay, O. P. 1898.1. — *In Keuper of Upper Silesia.* Michael, R. 1894.1.

Lepidosteus (*Gar-pike*). *Natural history, including distribution.* Coffin, C. E. 1874.1; Cope, E. D. 1865.3, 1870.4; Dunbar, G. P. 1882.1; K., S. 1877.1. — *Occurrence in prehistoric times (Stone Age).* Abbott, C. C. 1872.3.

Relationships. — *Relationship of Lepidosteus to Aspidorhynchus and Belonostomus.* Reis, M. Add. 1888.1. — *Lepidosteus sinensis; present status.* Wagner, G. 1912.1.

Fossil forms. Agassiz, J. L. 1848.3, 1850.7. — *In Miocene of Germany.* Andreae, A. 1893.1, 1894.1. — *In Oligocene of Saskatchewan.* Lambe, L. M. 1908.1. — *In Tertiary of Wyoming.* Marsh, O. C. 1871.1. — *In Cretaceous.* Osborn, H. F. 1902.1. — *In Eocene of N. America.* Cockerell, T. D. (*Utah*) 1909.1; Cope, E. D. (*Wyoming and New Mexico*) 1883.1; Eastman, C. R. (*Wyoming*) 1900.2,.5. — *In Eocene of France.* Dollo, L. 1893.3, Add. 1890.1; Gervais, F. L. (*Paris Basin*) 1874.2; Harting, P. (*Paris Basin*) 1875.6; Malaquin, A. G. 1900.1; Anon. 536.

SUB-CLASS DIPNOI

(Dipneusti) Lung-fishes

For maps showing the distribution of the recent Dipnoi, see Bridge, T. W. 1904.1 (*p.* 512), *and* Meek, A. 1916.1 (*p.* 57).

Natural history accounts. Bolau, C. C. 1901.1, 1910.1; Brandes, G. 1893.1; Dybowski, W. 1878.1; Perret, A. 1900.1; Anon. 348, 349, 350.

Structure and relationships of both recent and fossil forms. ★Ayers, H. 1885.1, 1893.2; ★Dollo, L. 1896.2; Miall, L. C. 1878.1; Watson, D. M. & Day, H. 1916.1. — *Affinities with extinct fishes.* Crane, A. 1877.1. — *Relation to Arthrodira.* Eastman, C. R. 1906.1. — *Relationship with Amphibia.* Semon, R. W. 1901.4; Zaddoch, E. G. 1873.1.

Fossil forms. — *In Permian and Triassic, United States.* Cope, E. D. 1877.2, 1884.4,.6. — *"Ctenodipterinen" of the Devonian.* ★Pander, C. H. 1858.1. — *Silurian of Oesel I., Russia.* Rohon, J. V. 1893.1. — *Mesozoic and Cenozoic.* Stromer, E. 1910.2. — *Taxonomy.* Woodward, A. S. 1889.2.

Family Ctenodontidæ

Palæozoic

Ctenodus. *Osteology.* Barkas, W. J. 1877.1, 1878.3,.4; Miall, L. C. 1878.2.

Relationships — to Ceratodus. Hancock, A. & Atthey, T. 1871.1. — *to fossil Amphibian, Eurythorax.* Hussakof, L. 1916.1.

Family Ceratodontidæ

Ceratodus (*fossil genus*). *Occurrence in Lower Mesozoic at Maledi, India.* Miall, L. C. 1878.3; Oldham, T. 1859.1.

Occurrence in Cretaceous. Osborn, H. F. 1902.1; Haug, E. (*Sahara*) 1904.1; Chapman, F. (*New South Wales*) Add. 1914.1; Cope, E. D. (*Montana*) Add. 1876.1.

Occurrence in Jurassic. Knight, W. C. 1898.1. — *Victoria.* Chapman, F. R. 1912.1; Woodward, A. S. 1906.5. — *Colorado.* Marsh, O. C. 1878.1–1878.3.

Occurrence in Permian. — *Illinois.* Cope, E. D. 1875.4. — *Bohemia.* Fritsch, A. J. 1874.2.

Occurrence in Post-Pliocene. De Vis, C. W. Add. 1884.1.

Occurrence in Triassic. — *Hungary.* Beyrich, H. E. 1850.1. — *England.*

Browne, A. M. 1893.1; Richardson, L. 1906.1. — *Austria.* Teller, F. J. 1891.1. — *Silesia.* Volz, W. T. 1896.1. — *Africa.* Woodward, A. S. 1889.7.

Structure (mainly skull and teeth) and taxonomy. Egerton, P. G. & Miall, L. 1877.1; Fraas, E. 1889.1, 1904.1; Sandberger, C. L. 1877.1, 1879.1; Seeley, H. G. 1897.1; Stur, D. R. J. 1886.1; Zittel, K. A. 1886.1.

Neoceratodus (*the recent form of Ceratodus*). *General treatise with fine figures.* ★Günther, A. C. 1871.4. — *Discovery, early descriptions, etc.* Krefft, J. L. 1870.1–1871.2; Putnam, F. W. 1872.5; Anon. 385, 389, 573.

Natural history, popular accounts, notes, etc. Bancroft, T. L. 1912.1, 1914.1; Becker, E. E. 1901.1; Bruyère, H. 1901.1; Dean, B. 1912.1; Godet, P. 1880.1; Gervais, F. L. 1876.1; Harting, P. 1872.3, 1876.1; Hector, J. 1875.3; Hoffmann, C. K. 1872.1; Illidge, T. 1893.1; Keller, C. 1880.1; König, C. 1911.1; Lindes, L. 1880.3; Meyer, A. B. 1875.1; Newman, E. 1872.1; O'Connor, D. 1897.1; Peters, W. C. 1871.1; Schmeltz, J. D. 1875.1; Stoddart, W. W. 1875.1; Troschel, F. H. 1871.2; Anon. 257; Harald, – Add. 1914.1,.2; Palmer, – Add. 1906.1.

Phylogeny and relationships. — Relation to Dipterus and Ctenodus. Hancock, A. & Atthey, T. 1871.1. — *Considered as a "living fossil."* Tribolet, G. 1899.1.

Taxonomy. Castelnau, F. L. 1876.2; Günther, A. C. 1871.2, 1872.1; Anon. 130.

Family Lepidosirenidæ

Taxonomy. Gill, T. N. 1894.1.

Lepidosiren. *General account with fine figures.* Lankester, E. R. 1896.1. — *Discovery, early descriptions, etc.* Fitzinger, L. J. 1837.2; Giglioli, E. H. (*Rediscovery*) 1887.2, 1888.2; Natterer, J. 1837.1; Schulz, W. A. (*History of discovery*) 1904.1.

Natural history, occurrence, etc. ★Baur, G. H. 1887.4; Bohls, J. 1894.1; Crane, A. 1877.1; Ehlers, E. H. 1894.1,.2; Goeldi, E. A. 1896.1, 1898.1,.2,.3; Günther, A. C. 1894.1; Harting, P. 1878.1; Heckel, J. J. 1845.1; Hoeven, J. 1837.1, 1839.1; ★Kerr, J. G. 1898.1; Leuckart, F. S. 1840.1; Merciai, G. 1906.1; Melville, A. G. 1847.1; Oken, L. 1838.1; Saint-Hilaire, A. F. 1846.1; Thompson, T. 1858.1; Howes, G. B. Add. 1893.1. — *Scarcity in European collections.* Sclater, P. L. 1866.1.

Taxonomy, relationships, etc. Duméril, A. H. 1870.3; Edwards, H. M. 1840.1; Peters, W. C. 1866.6; ★Ribeiro, A. de M. 1909.1; Schneider, A. F. 1886.1; Hogg, J. Add. 1841.1. — *As an Amphibian.* Asmuss, H. 1856.1.

Protopterus. *General accounts with excellent figures.* Lankester, E. R. 1896.1; Peters, W. C. 1844.3, 1866.1.

For summer sleep, see Aestivation *in the* Morphological Section.

Natural history accounts, notes, etc. Boulenger, G. A. 1901.12; Brandes, G. 1893.1; ★Budgett, J. S. 1900.3, 1907.1; ★Dean, B. 1903.4; Gray, J. E. 1860.1; Halkett, A. 1901.1; Harting, P. 1864.2; Levander, K. M. 1897.2; Maitland, R. T. 1863.1; Marno, E. 1873.2; Merle, R. 1913.1; Moore, T. J. 1867.1; Newman, E. 1857.1, 1859.1; Palmén, J. A. 1900.1; Shufeldt, R. W. 1893.1; ★Wiedersheim, R. E. 1887.5; Beauregard, H. Add. 1889.1; Boyer, J. Add. 1913.2; Schulze, F. E. Add. 1889.1; Weltner, W. Add. 1896.1; Umlauff, H. Add. 1895.1. — *Distribution.* Schlüter, C. A. 1866.1.

Taxonomy and relationships. Duméril, A. H. 1870.3; Heckel, J. J. 1851.6; Schneider, A. F. 1886.1; Walter, J. A. 1873.1; Vaillant, L. L. 1899.3; Hogg, J. Add. 1841.1.

Fossil in Pliocene of Egypt. Stromer, E. 1914.2.

ORDER TELEOSTEI

True bony fishes

Taxonomy and relationships. ★Boulenger, G. A. 1904.7,.11,.12; Canestrini, G. 1859.3; ★Gregory, W. K. 1907.1; ★Regan, C. T. 1909.4, 1912.13. — *Classification of Physostomi.* Borsieri, C. 1910.1. — *Relations of Teleostei with ganoids.* Huxley, T. H. 1883.2. — *Review of Japanese Isospondyli.* Jordan, D. S. & Herre, A. C. 1906.1. — *Allotriognathi.* Regan, C. T. 1907.11. — *Zeomorphi.* Regan, C. T. 1910.1. — *Iniomi.* Regan, C. T. 1911.2. — *Palæontological history.* Reis, O. M. 1895.3. — *Taxonomy of fossil forms.* ★Woodward, A. S. 1889.2.

Fossil forms from — Cretaceous. Cope, E. D. (*United States*) 1871.20; Cragin, F. W. (*Kansas*) 1901.1; Hay, O. P. 1903.2. — *Eocene, Wyoming, Green River shales.* Cope, E. D. 1870.5, 1877.1,.3. — *Tertiary, Idaho.* Cope, E. D. 1871.12.

SUB-ORDER MALACOPTERYGII

General account. Jordan, D. S. 1885.17. — *Of Denmark.* ★Otterstrøm, C. V. Add. 1914.1.

Taxonomy. — Relationship of families composing. Vaillant, L. L. 1883.1. — *Revision, African species.* Boulenger, G. A. Add. 1909.1.

Family Elopidæ

Elops (*Big-eyed Herring*). — *E. macropterus in Jurassic of France.* Prévost, C. 1824.1, Add. 1825.1. — *Taxonomy; revision.* Regan, C. T. 1909.14.

Megalops (*Tarpon or Tarpum*). *General popular treatises.* Pinckney, F. S. 1889.1; ★Dimock, A. W. Add. 1911.1.

Natural history accounts, descriptions, notes, etc. Bickerdyke, J. 1895.1; Clarke, S. C. 1874.1; Dunbar, G. P. 1882.1; ★Gill, T. N. 1907.6; Goode, G. B. 1874.5; Hutchinson, H. G. 1904.1; McIntosh, W. C. 1888.2; Murphy, J. J. 1880.1; Philips, B. 1874.8.

Family Albulidæ

Albula (*Lady-fish, Bone-fish*). *Natural history.* Clarke, S. C. 1877.1; Evermann, B. W. 1902.19; ★Gill, T. 1907.6.

Family Mormyridæ

For anatomy and functions of electrical organs, see under Electrical fishes.

For a map showing the distribution of the Mormyridæ, see Meek, A. 1916.1 (*p.* 62).

General treatise. Marcusen, J. 1864.1.

Phylogeny and natural history. Kammerer, P. 1906.1; ★Schlesinger, G. 1910.2,.4.

Taxonomy. — *Revisions.* ★Boulenger, G. A. 1898.17, 1901.22, Add. 1909.1; Marcusen, J. 1854.2, 1864.1. — *Synopsis.* Gill, T. N. 1863.2. — *German East Africa.* Pappenheim, P. 1906.2.

Mormyrus. *Natural history.* Babukhin, A. I. 1877.1.

Family Osteoglossidæ

For maps showing the distribution of Osteoglossid fishes, see Boulenger, G. A. 1904.7 (*p.* 557), *and* Meek, A. 1916.1 (*p.* 60).

Taxonomy. Boulenger, G. A. 1901.19.

Family Pantodontidæ

Pantodon. *Natural history of Pantodon, the freshwater flying fish of W. Africa.* Baird, S. F. 1876.13; Pellegrin, J. 1906.12; Popta, C. M. L. 1901.4.

Family Saurodontidæ

Structure, taxonomy and occurrence in Cretaceous of Kansas. Cope, E. D. 1871.15, 1872.9, 1892.3; Crook, A. R. 1892.1; Stewart, A. S. 1898.4, 1899.3.

Ichthyodectes. *Taxonomy; synopsis.* Hay, O. P. 1898.3.

Portheus. *Structure and classification.* Cope, E. D. 1872.5; Hay, O. P. 1898.4,.5; Longman, H. A. 1913.1; Osborn, H. F. 1904.1; Woodward, A. S. 1913.1.

Occurrence in Cretaceous of — *Bohemia.* Bayer, F. 1908.1, 1909.1. — *Kansas.* Cope, E. D. 1873.4; Sternberg, C. H. 1907.1, 1909.1; Williston, S. W. 1894.2. — *Africa.* Jaekel, O. 1909.1. — *Italy.* Mariani, E. 1902.1. — *British Isles.* Newton, E. T. 1877.2. — *Queensland.* Woodward, A. S. 1894.6.

Family Chirocentridæ

Taxonomy: Sunda-Molucca forms. Bleeker, P. 1852.3.

Family Clupeidæ

Herrings, Pilchards and Sardines, Shads, Alewives.

Natural history. Cuvier, G. & Valenciennes, A. 1848.1; Knox, R. 1846.1; Prince, E. E. 1907.1; Tracy, H. C. 1906.1; Widegren, H. 1872.2,.3, 1876.1. — *Of Caspian Sea species.* Borodin, N. A. 1905.2. — *Of Pacific coast forms.* Lockington, W. N. 1880.8. — *On coasts of Devon and Cornwall.* Dunn, M. Add. 1886.1, 1894.1.

Taxonomy. Bleeker, P. 1862.1 (vi), 1866.2; Fowler, H. W. 1911.6; Valenciennes, A. 1846.1. — *Caspian Sea; review.* ★Berg, L. S. 1913.5. — *Black Sea.* Brauner, A. 1912.1,.2. — *S. African species.* Gilchrist, J. D. 1913.3. — *Bonin Is.* Kishinouye, K. 1911.1. — *Pacific coast.* Lockington, W. N. 1880.15. — *Australia.* Macleay, W. 1880.3. — *Baltic Sea.* ★Schneider, G. 1908.2. — *Relation to Ganoidei.* Stannius, F. H. 1846.1.

Nomenclature. Goode, G. B. 1878.3; Philips, B. 1878.4.

Fossil forms; occurrence and geological significance. Rzehak, A. 1881.1, 1887.1. — *in Eocene of Monte Bolca.* Lioy, P. 1865.3. — *in Miocene of Transcaucasia.* Bogacev, V. V. Add. 1913.1.

Sub-family Engraulinæ

Engraulis (*Anchovy*). — *Complete literature and plate of larval forms.* ★Hoek, P. P. **1903.1**. — *General treatise.* ★Hoek, P. P. & others. **1886.1.**

Natural history. ★Fage, L. 1911.2; Fulton, T. W. 1902.1, 1905.2; Hoek, P. P. 1891.2, 1892.1; Marion, A. F. 1894.6, Add. 1889.1; Anon. 102. — *Japanese forms.* Nishikawa, T. 1901.1. — *Local races.* Fage, L. 1911.3; Lo Giudice, P. 1911.1,.2.

Occurrence. — *English coast.* Calderwood, W. L. 1892.2; Cunningham, J. T. 1889.1. — *Balearic Islands.* Racovitza, E. G. 1905.1.

Sub-family Clupeinæ

For maps showing the geographical distribution of the herrings and shads of the genus Clupea, see Meek, A. 1916.1 (*pp.* 104, 105).

Taxonomy. — *Black Sea forms.* Antipa, G. 1905.1. — *Synopsis.* Gill, T. N. 1862.28. — *British species.* Regan, C. T. 1916.1.

Alosa sapidissima (*American Shad*). *Natural history, occurrence, etc.* Ascroft, R. L. 1900.1; Evermann, B. W. 1902.1, 1906.13. — *In Hudson R.* Cheney, A. N. 1896.8, 1900.1. — *At Beaufort, North Carolina.* Anon. 405.

Brevoortia (*Menhaden*). *General treatise.* Goode, G. B. 1879.7.

Natural history. Gilpin, J. B. 1863.1; Goode, G. B. 1879.2,.9, 1880.17; Mosher, G. 1882.1; Stearns, S. 1879.1.

Taxonomy and nomenclature. — *Revision, American species.* Goode, G. B. 1878.11. — *Popular names.* Goode, G. B. 1878.13. — *Etymology of names.* Trumbull, J. H. & Josselyn, J. Add. 1879.1.

Clupea alosa (*Allis Shad*). *Natural history.* Hoek, P. P. 1897.3; Pollen, F. 1872.1; Pouchet, G. & Biétrix, E. 1889.1, .2; Reidel, W. 1894.1; Cunningham, J. T. Add. 1895.3.

Clupea finta (*Twait Shad*). *Natural history.* ★Ehrenbaum, E. 1896.1; Noël de la Morinière, S. B. 1810.1; Pouchet, G. & Biétrix, E. 1889.1; Supino, F. 1908.4. — *In lakes of northern Italy.*

Barbieri, C. 1908.3; Besana, G. 1908.2. — *On English coast.* Hogg, J. 1870.1.

Clupea harengus (*Sea Herring*). *General treatises.* Bock, F. S. 1769.1, Add. 1768.1; Caux, J. W. 1881.1; ★Heincke, F. **1898.1**; Møller, J. M. 1865.1; ★Valenciennes, A. **1847.1**. — *Complete literature, with plate of larval forms.* ★Hoek, P. 1903.1.

Migration and distribution. Baird, S. F. 1878.5; Broch, H. 1908.1,.2; Cligny, A. 1912.9; Duncker, G. 1899.1; Gilpin, J. 1786.1; Lindahl, J. 1878.1; Mitchell, J. M. 1861.1; Morrison, W. D. 1829.1; Noël de la Morinière, S. 1795.1; Nordgaard, O. 1905.1; Schneider, J. G. 1788.2; Sim, G. 1883.2; Watt, W. 1883.3; Ziegler, A. 1857.1; Anon. 366. — *English Channel.* Canu, E. 1897.1. — *In Baltic Sea.* Hinkelmann, A. 1908.1. — *Results of the international herring investigations, 1907–1911.* Hjort, J. 1908.1, 1910.2; Hjort, J. & Lea, E. 1911.1, 1912.1. — *Effect of climate.* Krebs, W. 1911.1. — *Sylt, Prussia.* Lübbert, H. O. 1904.1.

Natural history. Growth and age. Cunningham, J. T. 1891.4; Harting, P. 1879.3; Jenkins, J. T. 1903.1. — *In Baltic Sea.* Meyer, H. A. 1878.1,.2.

Natural history; text in English. Ewart, J. C. 1883.1, 1884.1,.2, 1888.3; Ewart, J., Gibson-Maitland, J. & others. 1884.1; Fraser, A. 1830.1, 1833.1; Gilpin, J. B. 1863.1; Heincke, F. 1899.1; Holt, E. W. L. 1889.1; Huxley, T. H. 1881.1; Knox, R. 1834.1; Kyle, H. M. 1899.1; Ljungman, A. V. 1882.2; Meyer, H. A. 1880.1; Mitchell, J. M. 1860.1, 1863.1,.2, 1864.1; Robertson, D. 1869.1; Warren, R. 1906.1; ★Williamson, H. C. 1910.2; Anon. 146, 469. Dodd, J. Pre-Linn. 1752.1.

Natural history; text in French. Cligny, A. 1904.1; Dulac, A. 1765.1; Giard, A. 1903.4, 1904.1; Noël de la Morinière, S. B. 1789.1; Sauvage, H. E. 1888.2.

Natural history; text in German. Ehrenbaum, E. 1909.2; Ekström, C. 1845.1; Lübbert, O. 1864.1; Nilsson, S. 1860.1; ★Simroth, H. R. 1910.1; Storch, O. 1915.1; Wilson, S. 1861.1; Anon. 276, 277, 378, 579, 615, 649; Heincke, F. Add. 1884.1.

Natural history; text in various languages. — *Danish.* Ljungman, A. V. 1879.1,.3; Otterstrøm, A. N. 1910.1. — *Latin.* Anon. 750; Hartung, V. Pre-Linn. 1615.1; Mattheus, A. Pre-Linn. 1649.1. — *Russian.* Pavlenko, M. N. Add. 1914.1. — *Swedish.* Ekström, C. U. 1844.2; Trybom, F. (*Reproductive organs*) 1901.1.

Races of herring. Broch, H. 1908.1,.2; Meek, A. 1914.1; Meek, A. & Storrow, B. 1912.1–1913.1; ★Orton, J. H. 1916.1; Scupin, E. 1910.1; Smitt, F. A. 1888.1; ★Stacy-Watson, C. 1894.1. — *Researches into European races, with methods.* ★Williamson, H. C. 1914.1. — *Species inhabiting the Oresund.* Winther, G. P. 1876.3, 1878.2. — *Heincke's investigations.* ★Heincke, F. 1877.1, 1898.1, 1899.1; Redeke, H. C. 1901.2. — *Application of Heincke's method to English waters.* Riddell, W. 1914.1, 1915.1.

For Clupea alba, the young of C. harengus, see Whitebait *under* Fisheries by subjects.

Clupea pilchardus (*Pilchard*). *Natural history.* Cêpède, C. 1907.2; Cornish, T. 1870.5, 1879.1; Cunningham, J. T. 1892.4, 1893.6; Couch, J. 1865.1; Dunn, M. 1892.1; ★Fage, L. 1912.3, 1913.1; Fulton, T. W. 1904.1; Hoek, P. P. 1913.2; Fage, L. & Legendre, R. Add. 1914.1.

Natural history of the Sardine, the immature form of the Pilchard. Cuvier, G. L. & Valenciennes, A. 1848.1; ★Kishinouye, K. 1907.3. — *On French and Italian coasts.* ★Mader, C. **1909.1**; Marion, A. F. 1889.1–1891.2, 1894.10,.11, Add. 1889.2; Pouchet, G. 1886.1–1891.3; Pouchet, G. & Biétrix, E. 1892.1; Steuer, A. 1908.1; Henneguy, L. F. Add. 1891.1; Joubin, L. Add. 1913.1.

Papers dealing especially with the Sardine will be found chiefly under Fisheries, Sardine.

Clupea sprattus (*Sprat*). *Natural history and occurrence.* Costa, O. G. 1844.2; Noël de la Morinière, S. B. 1798.1. — *In New Zealand.* Arthur, W. 1883.1. — *In Baltic Sea.* Schneider, G. 1895.1. — *In Norway.* ★Sund, O. 1909.1, **1910.1,.2.**

Clupea, *in Caspian Sea and Sea of Azov.* — *Sea of Azov.* Grimm, O. 1901.1.

Natural history of species of Caspian Sea and Volga R. Borodin, N. A. 1896.1, 1904.1; Kuznetzov, I. D. 1904.1; Pel'tzam, E. D. Add. 1886.1. — *C. caspia.* Arnold, D. J. 1907.1; Kuznetzov, I. D. 1894.1; Suvorov, E. K. (*taxonomy*) 1907.3. — *C. cultiventris and C. engrauliformis.* Borodin, N. A. 1905.3, 1906.1. — *C. kessleri.* Dikson, B. 1905.2,.3.

Clupea. *Fossil forms.* — *in Sardinia.* Bassani, F. 1900.1. — *in Cretaceous and Tertiary of Croatia.* Kner, R. 1863.3. — *Eocene of Wyoming.* Leidy, J. 1857.1. — *Oligocene, Isle of Wight.* Newton, E. T. 1889.2. — *Tertiary of France.* Sauvage, H. E. 1881.1.

Dorosoma (*Gizzard Shad*). *Taxonomy.* Jordan, D. S. 1877.1.

Diplomystus. *Recent forms.* — *in freshwater of Australia.* Woodward, A. S. 1892.2. — *Relation to Potamolosa and Hyperlophus.* Ogilby, J. D. Add. 1896.1.

Fossil forms. — *in Tertiary of Africa.* Eastman, C. R. 1912.2. — *in Cretaceous of Brazil.* Mawson, J. & Woodward, A. S. 1907.1.

Pomolobus (*Alewife, or River or Branch Herring*). *How to distinguish the two species of river herring.* Goode, G. B. 1879.16, 1880.13.

Fisheries, United States. Smith, H. M. 1899.6; Crittenden, A. R. Add. 1884.1. — *Massachusetts.* Field, G. W. 1914.1. — *Potomac R.* Harris, G. 1884.1–1887.1. — *Louisiana.* Harrell, J. D. Add. 1884.1. — *North Carolina.* Milner, J. W. Add. 1882.1; Worth, S. G. Add. 1884.1.

Natural history, occurrence, etc. Bean, T. H. 1884.7; Green, S. 1880.1; ★McDonald, M. 1884.5; Milner, J. W. 1880.4; Yarrow, H. C. & Milner, J. W. 1874.1.

FAMILY SALMONIDÆ

For a map showing the geographical distribution of the Salmonidæ, see Boulenger, G. A. 1904.7 (*p.* 566).

Distribution

General. Bean, T. H. 1888.2; Blyth, E. 1865.1; Norris, T. 1862.1.

Northernmost salmonoid, Salvelinus arcturus from Victoria Lake and Floe-Berg Beach. 82° 28′ N.; Günther, A. 1877.1. — [*Peary Exped. collected trout in outlet of Lake Hazen, still farther north.*] — *S. stagnalis in Arctic circle.* Bean, T. H. Add. 1886.1.

Southernmost New-world distribution; Salmo mykiss (S. Clarkii) in Chihuahua. Cope, E. D. Add. 1886.3. — *S. nelsoni in Lower California.* Evermann, B. W. 1908.1.

Southernmost Old-world distribution; Salmo macrostigma in Algeria. Duméril, A. H. 1858.3, 1863.1; Zill, - (*S. lapasseti*) 1858.1. — *in Sardinia.* Boulenger, G. A. 1900.15. — *in Pontine marshes, Italy.* Vinciguerra, D. 1902.1.

Southernmost Asian distribution; Salmo orientalis in northern Afghanistan. M'Clelland, J. 1835.1, 1843.1. — *Phylogephyra in the Altai Mts.* Boulenger, G. A. 1898.11.

Embryology

Because of the ease in securing them, salmonid eggs have served as the basis of most of the embryological work on fishes. The following represent a few of the more important general researches. ★Henneguy, L. F. 1888.1; ★His, W. 1874.2, 1876.1, 1878.1, 1879.2, 1880.1; Jablonovskij, J. 1898.1; Kopsch, F. 1894.1, 1898.1; Lereboullet, D. A. 1861.1; Oellacher, J. 1879.1; Ryder, J. A. 1885.6; ★Vogt, C. C. **1842.1**; Ziegler, H. E. 1882.1.

Fossil forms

Rhabdofario lacustris from Pleistocene at Catherine's Creek, Idaho. Cope, E. D. 1871.12.

Thaumaturus and Prothymallus from Lower Miocene of Bohemia. Laube, G. C. 1900.1,.2.

Taxonomy

Key to genera. Bean, T. H. 1888.4. — *Cranial characters.* Boulenger, G. A. 1895.10. — *Differential characters of Salmonidæ and Thymallidæ.* Gill, T. N. 1895.1, Add. 1896.1. — *Systematic arrangement.* ★Regan, C. T. 1914.11.

General treatises. *Encyc. article.* Cunningham, J. T. 1886.3. — *See also acc't by ★G. A. Boulenger, Encyc. Brit.* 1911, *vol.* 24, *p.* 82.

For a complete taxonomic account to 1866, *see vol.* VI *of* ★Günther, A. 1859.1.

General treatises on American Salmonidæ. Garman, S. 1885.1. — *Note on this.* Jordan, D. S. 1886.4; Suckley, G. 1860.1–1874.1. — *Note on this.* Baird, S. F. Add. 1874.2. — *See especially* ★Jordan, D. S. & Evermann, B. W. **1896.2,** 1902.1.

General treatises on the Salmonidæ of Europe. Fatio, V. (*Vol.* 5) 1882.1; Kavraiskii, T. T. 1896.1; ★Smitt, F. A. 1882.1, **1886.1.**

British and Irish Salmonidæ. ★Day, F. **1887.1;** Holt, E. W. & Byrne, L. W. 1913.1; Jardine, W. 1834.3, 1839.1,.2. — *See especially, acc't in* ★Regan, C. T. 1911.8.

Salmonidæ of Japan. Hilgendorf, F. M. 1876.1; Jordan, D. S. 1902.11, 1905.3; ★Jordan, D. S. & Snyder, J. O. 1902.6; Kitahara, T. 1904.2.

SUB-FAMILY SALMONINAE

The Salmons and Trouts

For a map showing the geographical distribution of the Atlantic and Pacific Salmons and Trouts, see Meek, A. 1916.1 (*p.* 114).

SALMO (TROUTS)

American trouts

For the best systematic accounts, see Garman, S. 1885.1; ★Jordan, D. S. & Evermann, B. W. 1896.2, 1902.1. — *Popular acc't.* Sage, D. & others. 1902.1.

Miscellaneous. Chamberlain, F. M. 1907.1; Gibbons, W. P. 1876.1; Gilpin, J. B. 1863.1; Jordan, D. S. 1894.4, Add. 1892.1,.2; Land, S. E. 1913.1; Stone, L. 1872.5.

Salmo gairdneri. *Steelhead Trout series.* — *S. kamloops in Kootenay Lake, B. C.* Jordan, D. S. & Snyder, J. O. 1908.2.

Salmo clarkii. *Cut-throat Trout series.* — *Popular acc't.* Evermann, B. W. 1903.1. — *S. eremogenes, n. sp.=S. clarkii.* Evermann & Nichols, J. T. 1909.1. — *Misc.* Jordan, D. S. 1885.10. — *S. virginalis of Utah Lake.* Yarrow, H. C. 1874.3.

Twin Lake (Colo.) trouts — S. stomias. Cope, E. D. 1875.9; Juday, C. 1907.2. — *S. macdonaldi.* Jordan & Evermann. 1890.1.

Lake Tahoe (Cal.) trouts. — S. henshawi, and S. tahoensis. Juday, C. 1907.1. — *S. regalis.* Snyder, J. O. 1912.4.

Salmo irideus. *Rainbow Trout series.* — *Popular acc't.* Bean, T. H. 1896.2. — *Original description.* Gibbons, W. P. 1855.1.

Golden trout, S. agua-bonita of the south fork of Kern R., Cal. Evermann, B. W. 1904.3,.4, 1906.7,.14; Jordan, D. S. 1893.1, Add. 1892.3; Juday, C. (*Food*) 1906.1.

S. roosevelti, and S. whitei, n. sps., golden trouts of Kern R. region. Evermann, B. W. 1906.7.

European trouts

Taxonomy, species — of Europe. Agassiz, J. L. 1834.6; Günther, A. 1895.1. — *of British Isles.* Day, F. 1883.6. — *of Central Europe.* Heckel, J. J. & Kner, R. 1858.1. — *of Caucasian regions.* ★Kavraiskii, T. T. 1896.1, 1899.1.

Trout, "Carpione" of the Lake of Garda (S. carpio). Betta, F. E. 1891.1; Heckel, J. J. 1852.5; B., J. Add. 1899.2.

Salmo trutta. *All British trouts are now considered to belong to a single variable species, S. trutta (S. fario, syn.). For convenience in reference however the following sub-divisions are retained.*

General treatises on natural history and the trout as a game fish. Granby, — 1898.1; Harvie-Brown, J. A. 1898.1; Jourdeuil, E. 1872.1; ★Lamond, H. **1916.1**; ★Malloch, P. D. **1910.1**; Maxwell, H. E. 1898.1; Petit, G. 1897.1; Phillips, E. 1914.1.

Growth, biometric correlations. Jenkinson, J. W. 1912.1. — *"Yellow fins," as second year trout.* McIntosh, W. C. 1871.1; Flowerdew, H. Add. 1883.1.

Gillaroo or gizzard trout of Irish lakes (S. stomachius). Barrington, D. 1774.1; Hunter, J. 1774.2; Thompson, W. 1849.1; Walsh, J. 1774.1; Watson, H. 1775.1.

Loch Leven trout (S. levenensis), status. Day, F. 1890.3.

"Tailless trout" of Loch-na-Maorachan in Islay, Scotland (S. islayensis). Peach, C. W. 1871.1; Thomson, J. 1873.1; Traquair, R. H. 1872.1, 1882.2, 1892.5.

Sea-trout, Bull-trout, or Salmon-trout (S. eriox), i. e. references to marine or estuarine forms. Growth, habits, migrations, etc. Barfurth, D. 1874.1–1886.1; Blackwall, J. 1850.1; Brotherson, A. 1882.1; Calderwood, W. L. 1904.4; Cligny, A. 1907.1, 1912.12, Add. 1907.3; Dahl, K. 1911.1; Giard, A. 1892.2; Green, R. Y. 1889.1; Hoek, P. P. 1892.2; Jardine, W. 1830.1, 1834.1; Klunzinger, C. B. 1885.1; Nordgaard, O. 1896.1–1897.2; Shaw, J. 1843.1; Sicard, A. 1865.1; Vacher, — 1892.1; Williamson, H. C. 1896.1. — *Bull-trout of Tay is in reality the salmon.* Calderwood, W. L. 1906.1.

SALMO SALAR
(Atlantic Salmon)

References to American forms

For popular accounts, see ★Jordan, D. S. & Evermann, B. W. 1902.1; Sage, D. & others. 1902.1.

Records of capture of Atlantic salmon at sea. Kendall, W. C. & Smith, H. M. 1895.1; Smith, H. M. 1895.2.

Records of reappearance in Connecticut R., due to planting. Baird, S. F. 1876.1; C., G. H. 1878.1; Chalmers, T. 1878.4; G. - 1876.1; Gladwin, C. O. 1876.2; Philips, B. 1878.11.

Marking experiments at Bucksport on Penobscot R., Maine. Atkins, C. G. 1885.1.

Miscellaneous papers on habits, etc. of salmon. D., R. G. 1879.1; Gilpin, J. B. 1873.1, Add. 1879.1; Hind, H. Y. 1880.1–.4; Lord, W. S. (*weights*) 1882.1; Thacher, J. & Smith, S. 1874.1; Henry, W. Add. 1838.1.

Salmo salar ouananiche. *Ouananiche or Winninish of Lake St. John, Saguenay R., and Quebec.*

Popular general accounts. Chambers, E. T. 1896.1; McCarthy, E. 1894.1.

Miscellaneous papers. Boardman, G. A. 1875.1; Evermann, B. W. 1896.4; Grant, M. 1898.1; Huard, V. A. 1900.1, .2; Maison, E. 1897.3, 1899.1; Anon. 481, 699.

Salmo salar sebago. *Landlocked or Sebago salmon of Maine, New Hampshire, and New Brunswick.*

Miscellaneous items. Baird, S. F. 1871.26; Bean, T. H. 1889.11, 1890.41, 1891.10; Bowles, B. F. 1873.1; Jordan, D. S. 1878.4; Methuany, J. M. 1879.1; Philips, B. 1874.4; R., R. 1874.1; Stone, L. 1871.1.

References to European form

Popular articles on the salmon. Day, F. 1882.10; ★McIntosh, W. C. 1914.1.

Chemical composition of flesh; red color due to lipochrome pigment corresponding to tetron- or zoonerythrin. Christison, R. 1872.1; Kensington, E. T. 1884.1; ★Newbigin, M. I. 1900.1; Prince, E. E. 1916.2.

Thames as a salmon river. Marston, R. B. 1899.1; Venables, G. 1858.1, 1874.1.

Further relatively unimportant references to salmon will be found below, under Miscellaneous references.

General treatises. (*Text in English.*) *Life-history and habits.* Brown, W. 1862.1; ★Calderwood, W. L. **1907.1**, 1909.2; Davy, H. 1828.1; Fitzgibbon, E. & Young, A. 1850.1; Hardy, A. E. 1898.1; ★Malloch, P. D. **1910.1**; Maxwell, H. E. 1898.1; Traherne, J. P. 1889.1; Willis-Bund, J. W. 1885.1.

Growth. *Young stages, etc., observations on, and controversy over status of the botcher, gillion, grilse, gravelling, parr, samlet, etc.* Andrews, W. 1849.1,.2; Carr, J. 1810.1, Add. 1830.1; Cornish, T. 1868.6; Fryer, C. E. 1873.1; G., T. 1834.3; Jenkins, T. 1840.1; Wilson, J. 1840.1; Young, A. 1842.1–1854.1; Flowerdew, H. Add. 1883.1.

Parr proved to be young salmon by hatching and rearing fry to the parr stage. Shaw, J. 1836.1–1850.1. — *Color plates of growth during first two years.* Yarrell, W. 1839.2.

Exhibit of transition from smolt to grilse. Calderwood, W. L. 1906.3,.4. — *Alleged arrested development, when retained in fresh water.* Murie, J. 1868.1, 1870.1.

Life and growth of smolts in the open sea; feeding habits; return as grilse, etc. ★Dahl, K. **1911.1**; Archer, W. E. Add. 1893.1.

Size attained by salmon. — *49 lb. spm. from R. Maas, Holland.* Hughes, W. R. 1875.1. — *Large spms. from Severn and Wye.* — *80 lb. spm.* Jones, W. 1873.1. — *42 and 52 lb. spms.* Sweetapple, E. 1867.1. — *43 lb. spm.* Anon. 364.

Study of scales; "scale reading" for determination of growth, migrations, etc. Dahl, K. 1910.1; Esdaile, P. C. 1912.1, 1913.1; Hoek, P. P. 1909.2; Hutton, J. A. 1913.1, Add. 1909.1; ★Johnston, H. W. 1907.1, 1911.1; ★Masterman, A. T. 1913.1; Menzies, W. J. 1913.1.

Metabolism during sojourn in fresh water; question of feeding, etc., *text chiefly in English.* [*Now generally accepted that salmon do not feed while in fresh water.*]

Important treatises including papers on growth of the genitalia. Archer, W. E. 1900.2; ★Hoek, P. P. 1891.4, 1894.2, **1894.4**, 1896.2, 1899.1; ★Miescher-Ruesch, F. **1883.1**, 1879.1–1896.1, Add. **1897.1**; ★Paton, D. N. 1897.1–1908.1, **1898.1**; Paton, D. N. & Newbigin, M. I. 1902.1. — *Popular résumé of Miescher.* Henderson, Y. 1902.1.

Minor papers regarding the question of feeding in fresh water. Barfurth, D. 1876.1; Blackwall, J. 1843.1, 1850.1; Braithwaite, G. F. 1863.1; Buckland, F. T. 1879.1; Corbin, G. B. 1874.1; Halliburton, W. D. 1898.1; Houghton, W. 1868.1; Keene, J. H. 1879.3; McIntosh, W. C. 1864.1; Stark, John. 1840.1.

Researches, on the anatomy and histology of the intestine with regard to the possibility of food-taking. — *Degeneration of lining membrane of stomach.* Gulland, G. L. 1898.1,.2, 1900.1. — *Denial of this.* Barton, E. L. 1900.1–1904.1; Brown, A. B. 1898.1. — *Low activity of digestive processes.* Gillespie, A. L. 1898.1. — *Muscle fat, histology.* Mahalanobis, S. C. 1898.1, Add. 1898.1. — *Examination, stomachs of 514 fish at Berwick-on-Tweed.* Tosh, J. R. 1895.1.

For Protamines, *discovered by Miescher in salmon sperm, see* Chemical composition *under* Spermatozoa. *See also* Duration of virility *under* Spermatozoa.

Migrations. *Miscellaneous.* Benecke, B. 1886.2; Carr, J. 1809.1; Day, F. 1886.1; Nordqvist, O. F. 1906.3; Willis-Bund, J. W. 1902.1, 1905.1.

Relation to water temperature, etc. ★Calderwood, W. L. 1898.1, 1901.3, 1903.3, 1905.1. — *Capture at sea.* Cornish, T. 1881.6. — *Reach headwaters of Vistula R. in Carpathians.* Lindes, L. 1880.5. — *Influence of dissolved oxygen.* Roule, L. 1914.3,.4, 1915.2.

Migrations in Baltic and North Seas. ★Dahl, K. 1902.1,.2, 1906.3; Fiedler, J. 1885.1; Malmgren, A. J. 1884.2.

Supposed land-locked form, S. salar in Waterford Co., Ireland. Scharff, R. F. 1896.2.

Marking experiments for determination of migrations, growth, etc. — *in Tay, and Tweed, England.* Calderwood, W. L. 1902.1, 1906.3, Add. 1911.1,.2, 1914.2; Smith, G. 1861.1. — *in Ireland.* ★Hillas, A. B. 1904.1. — *in Germany.* Häpke, L. 1895.1; Virchow, R. & Hensen, — 1872.1; Nierstrass, H. F., Nengermann, A. A. & Kerbert, C. Add. 1911.1. — *in Norway.* Landmark, A. 1892.1. — *in Finland.* Nordqvist, O. F. 1897.2. — *Salmon marked in Finland, captured in Denmark and Germany.* Sandman, J. A. 1906.3, 1907.1, 1909.1. — *in Baltic Sea.* ★Trybom, F. 1908.1, 1910.1.

Reproduction. — *Sexual differences at breeding time and their causes.* Barrett-Hamilton, G. E. 1900.1, 1902.1. — *Range of spawning season in Scotland, sex-ratio, etc.* ★Calderwood, W. L. 1901.1, 1904.1. *Experiments at Plymouth laboratory.* Crawshay, L. R. 1908.1. — *Salmon do not spawn at sea.* Day, F. 1882.3, 1886.4. — *Exchange of pigments between muscle and ovary.* Newbigin, M. I. 1900.1.

Infrequency of spawning as shown by scales. Calderwood, W. L. 1910.1; Menzies, W. J. 1912.1, 1914.1.

Marine existence unnecessary for reproduction. — *Breeding of smolts which have never been to sea.* Calderwood, W. L. 1905.2; Day, F. 1888.4. — *Male kelt kept a year and found again ripe.* Calderwood, W. L. 1908.1.

PACIFIC SALMONS

Of the genus Oncorhynchus

Popular accounts, magazine articles, etc., on the life-histories and habits of the Pacific salmons. Bean, T. H. 1890.1; Jordan, D. S. 1881.6, 1894.4, 1903.4; ★Rutter, C. M. 1902.1, 1903.1; Stone, L. 1884.1; Townsend, C. H. & Smith, H. M. 1902.1. — *See also* ★Jordan, D. S. & Gilbert, C. H. 1881.1. *Reprinted in* Jordan & Evermann, 1902.1.

Color plates of all species. ★Evermann, B. W. & Goldsborough, E. L. 1906.2.

Chinook names of Columbia river salmon. Smith, Silas B. 1881.1.

Death after spawning. *Belief of Stone that all die, disbelief of this by others and the attendant controversy.* Bean, T. H. 1891.6; Dunn, H. D. 1880.1; Major, — 1879.1; Redding, B. B. 1879.2; Stone, L. 1880.1.

First conclusively shown that all die after spawning. Evermann, B. W. 1897.5.

Death invariably follows spawning, (in reared, uninjured salmon at the Trocadero aquarium in Paris) — *thus, a deep-seated, specific phenomenon.* Juillerat, E. 1905.1.

Growth and reproduction. *Natural history, etc.* — *In Alaska.* Bean, T. H. 1885.5, 1894.4. — *Figures, fry of all species.* ★Chamberlain, F. M. 1907.1. — *Age at maturity.* Gilbert, C. H. 1912.1.

Investigations ★, *on life histories in headwaters of the Columbia R.* Evermann, B. W. 1896.3, 1897.5; Evermann & Meek, S. E. 1898.1; Evermann & Scovell, J. T. 1895.2; Gilbert, C. H. & Evermann. 1895.1.

Marine existence unnecessary — *breeding of chinooks for several generations in fresh-water at the Trocadero.* Jousset de B., G. 1897.2; Raveret-W., C. & Bartet, — . 1873.1.

Scale markings studied for determination of the life-cycle. ★Gilbert, C. H. 1912.1, 1914.1; McMurrich, J. P. 1911.1, 1913.2, 1914.2; Milne, J. A. 1913.1.

Blue-back, red, or sockeye salmon, O. nerka. — *Kennerley's salmon as a small variety.* Bean, T. H. 1891.9; Bendire, C. E. 1878.1–1882.1. — *Note.* Brew, C. 1861.1. — *Popular acc'ts.* Evermann, B. W. 1902.16; Green, A. 1891.1,.2. — *Natural history.* ★Gilbert, C. H. 1912.2, 1914.1.

Chinook or Quinnat salmon, O. tschawytscha. — *Investigations of natural history in the Sacramento R.* ★Rutter, C. M. **1904.1.** — *Habits, size, non-feeding in fresh-water, etc.* Cobb, J. N. 1910.1; Goudy, J. (82 *lb. spm.*) 1878.1; Stone, L. 1874.2, 1884.6, 1895.1. — *Intestine, anatomy.* Greene, C. W. 1912.3. — *Musculature.* Greene, C. W. 1913.1; Greene, C. W. & Greene, C. H. Add. 1914.1.

Migrations. — *Speed of migrating salmon.* Greene, C. W. 1910.1,.2, 1911.1. — *Storage of fat in muscular tissues and its resorption during migrations.* ★Greene, C. W. 1912.1–.6, Add. 1914.1,.2. — *Parent stream theory.* Jordan, D. S. 1903.2. — *Experiment in land-locking quinnat salmon.* Parker, H. G. 1878.1. — *Migrations as shown by parasites.* Ward, H. B. 1908.1. — *Factors which control leaping.* Ward, H. B. 1910.1,.3,.4.

Marking experiments on Columbia R. Greene, C. W. 1910.1,.2, 1911.1; Smith, H. M. 1904.12, 1905.7, Add. 1905.1.

SALVELINUS (CHARRS)

For a map showing the geographical distribution of the Charrs, see Meek, A. 1916.1 (*p.* 132).

American forms

General treatises on the American charrs. Garman, S. 1885.1; Jordan & Evermann, 1896.2; ★Kendall, W. C. 1905.2, **1914.2.**

Salvelinus bairdii (*S. malma*). *Dolly Varden trout of the Pacific slope.* — *Color plate.* Evermann, B. W. & Goldsborough, E. L. 1906.2. — *In British Columbia.* Lord, J. K. 1867.3.

S. marstoni. Lac de Marbre trout of the Prov. of Quebec. Garman, S. 1893.1; Titcomb, J. W. 1901.1; Halkett, A. Add. 1914.1.

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S. oquassa. Blueback trout of Rangeley lakes, Maine. Baird, S. F. 1874.4; Bullen, A. 1879.1; ★Kendall, W. C. 1905.2, 1914.2; Kingsbury, C. A. 1874.1; Page, G. S. 1874.2.

S. aureolus. Golden trout of Sunapee Lake (*N. H.*), *and Flood Pond, Maine.* — *Original description.* Bean, T. H. 1887.6. — *Color plates.* ★Kendall, W. C. 1913.1, *correctly in Rept. U. S. Bur. Fish.*, 1912 (1914).

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Forelle, Bachforelle, Meerforelle, u. s. w. Agassiz, J. L. 1850.10; Ahlers, C. 1900.1; Braess, M. 1910.1; Bruttan, - 1888.1; Fitzinger, L. J. 1876.1; Heckel, J. J. 1852.2; Klunzinger, C. B. 1885.1, 1907.1; Liebe, C. 1875.1; Löns, H. 1908.2, 1912.1; Martell, P. 1916.1; Schmid, R. 1876.1; Schneider, M. 1898.1; Schubart, A. 1910.1; Schüz, E. 1866.1; Sprenger, W. 1901.3; Wartmann, B. (*S. illanca*) 1783.4; Zur Mühlen, M. 1911.5.

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Text in Russian. Arsenjev, V. 1909.1; Baženov, A. 1905.2; Berg, L. S. 1908.5, .6,.7; Heide, E. J. 1911.1, 1912.2; Soldatov, V. K. 1912.1,.2; Emeljanenko, N. Add. 1913.1.

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Sub-family Coregoninæ
The whitefishes

Revisions, American species. Bean, T. H. 1884.10; Evermann, B. W. & Smith, H. M. 1896.1. —*Great Lakes.* ★Jordan, D. S. & Evermann, B. W. 1911.1.

Whitefishes of —German and Swiss lakes, chiefly Lake of Constance. Fatio, V. 1884.1,.2, 1885.1,.2, 1896.1–1902.1, Add. 1885.1; Klunzinger, C. B. 1884.2; Krebs, W. 1904.1; Lochner von Hüttenbach, – 1904.1; Nüsslin, O. 1882.1,.2, 1884.1, 1903.2. —*Lake Onega, Russia.* Mikhailovskiĭ, M. M. 1903.2. —*Loch Lomond, Scotland; taxonomy.* Parnell, R. 1838.2.

Argyrosomus (*Cisco*). *Occurrence in —Lake Tippecanoe, Indiana.* Jordan, D. S. 1875.1. —*Indiana lakes.* Lower, W. I. Add. 1913.1.

Economic importance. Wagner, G. 1908.2, 1909.1.

Coregonus (*Whitefish*). *Occurrence — in northern Germany.* Eisfeld, H. 1880.1; Seligo, A. 1894.2. —*in Lake of Constance.* Klunzinger, C. B. 1903.1, 1904.1, 1905.1; Nüsslin, O. 1901.1,.2, 1903.1, 1904.1, 1905.1. —*in Wütasaari district, Finland.* Nordqvist, O. F. 1897.6. —*in Ticino, Switzerland.* Pavesi, P. 1898.1. —*in New York.* Smith, H. M. 1895.3. —*in Lake Peipus, Russia.* Zur Mühlen, M. 1911.27.

For a map showing the geographical distribution of the genus Coregonus, see Meek, A. 1916.1 (*p.* 136).

Natural history, European forms, chiefly in Lake of Constance. Besana, G. 1900.1; Bloch, M. E. 1779.1; Dröscher, W. 1907.1; Ericsson, B. 1905.1; Goll, H. 1882.1, 1883.1, 1892.2; Grube, A. E. 1878.1; Hofer, B. (*Ammersee, Bavaria*) 1908.2; Maier, H. N. 1910.1; Nordqvist, O. F. 1897.3; Nüsslin, O. 1903.2, 1907.1, .2,.3, 1908.1, 1910.1; Schwarz, J. 1911.2; Schillinger, A. 1896.1; Schweizer, W. 1894.1, 1916.1; Siebold, C. T. E. 1858.1; Sjöberg, H. R. A. 1897.2; Wartmann, B. 1777.2; Zur Mühlen, M. 1911.21; Anon. 273, 613.

Natural history, British and American species. Embleton, D. 1877.1; Fowler, H. W. 1905.2; Francis, F. 1878.2; Knox, R. 1834.1; Ward, H. B. 1896.2; Hankinson, T. L. (*Young*) Add. 1914.2; Lydekker, R. Add. 1906.5.

Taxonomy, British and Irish species; revision. Regan, C. T. 1908.18.

Variations. — Variability in Lake Erie. Putnam, F. W. 1866.2. — *C. fera, originally from Bodensee, giving rise to C. fera sancti-benedicti, n. var. in Laachersee, Prussia, after 40 years' isolation.* Thienemann, A. 1911.2, 1912.5, 1914.1.

Sub-family Thymallinæ

Taxonomy. Gill, T. N. 1895.1, Add. 1896.1.

Thymallus (*Grayling*). *Distribution.* Goode, G. B. & Bean, T. H. 1879.13. — *For map showing the geographical distribution, see* Meek, A. 1916.1 (*p.* 137).

Natural history notes, popular articles, etc. Berg, L. S. 1908.8; Bissell, J. H. 1893.2; Bullock, W. J. 1879.1; Dean, H. D. 1913.1; Evermann, B. W. 1905.14, 1906.8; Fatio, V. 1902.1; ★Henshall, J. A. 1899.1; ★Hofer, J. 1895.1; ★Hutchinson, H. G. 1904.1; Norris, T. 1879.12; Parker, J. C. 1889.2; Raveret-Wattel, C. 1889.2; Watkins, M. G. 1896.2; Whitaker, H. 1887.1; Calderwood, W. L. Add. 1891.1; Day, G. M. Add. 1892.1; Norris, T. Add. 1883.1; Helwing, G. Pre-Linn. 1718.1.

Taxonomy, review, North American forms. Milner, J. W. 1874.3.

Thymallus vexillifer, general account. Warnimont, J. 1870.1.

Sub-family Argentininæ

For a map showing geographical distribution, see Meek, A. 1916.1 (*p.* 141).

Taxonomy. — Synopsis of genera. Gill, T. N. 1863.18. — *Review, Japanese forms.* Jordan, D. S. & Snyder, J. O. 1902.6.

Argentina. *Natural history.* Fulton, T. W. 1901.1; Nozeman, C. Pre-Linn. 1758.1.

Occurrence in — Scotland. Edwards, T. 1881.1; Peach, C. W. 1859.2. — *Sable I. Bank, off Nova Scotia.* Goode, G. B. & Bean, T. H. 1878.2. — *Great Britain.* Holt, E. W. L. 1897.2. — *New Zealand.* Hutton, F. W. 1879.1. — *Japan.* Kishinouye, K. 1904.2.

For a map showing the geographical distribution of the genus Argentina, see Meek, A. 1916.1 (*p.* 144).

Hypomesus (*Surf Smelt*). *Popular account, with fishing methods of the Quillehute Indians, west coast of Washington (state).* Swan, J. G. 1880.1.

Mallotus (*Capelin*). *Natural history.* Cormack, W. E. 1826.1; Jones, J. M. 1878.1; Hardy, C. 1867.1.

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Osmerus (*Smelt*). *Fisheries. — in Russia.* Ergomysev, N. 1910.1; Samsonov, N. A. (*Livonia*) 1910.1. — *in the Netherlands.* Redeke, H. C. 1914.3. — *in Norfolk, England.* Southwell, T. 1884.1,.3.

Natural history notes, habitat, occurrence, etc. Coward, T. A. 1912.1; Duméril, A. H. 1866.4; ★Ehrenbaum, E. 1896.1; Feddersen, A. F. 1870.3; Herbert, H. W. 1882.1; Jordan, D. S. 1878.4; Kuchin, I. B. (*Ilmen Lake*) 1903.1; Noël de la Morinière, S. 1798.1; ★Nordqvist, O. F. 1910.6; Norris, T. 1862.2, 1874.8; Rice, H. J. 1878.3; Schneider, G. 1902.4; Ordway, J. P. Add. 1875.1. — *O. arcticus; practical and scientific investigations in Finmark.* ★Sars, G. O. 1879.3, 1883.1.

Taxonomy, Review of California species. Fisk, M. 1913.1.

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Sub-family Microstominæ

Taxonomy. Gill, T. N. 1865.7.

Sub-family Salanginæ

Taxonomy, Japanese species. Jordan, D. S. & Snyder, J. O. (*review*) 1902.6; Wakiya, Y. & Takahashi, M. 1913.1. — *Synopsis.* Regan, C. T. 1908.20.

Family Stomiatidæ

Taxonomy. — Ireland. Holt, E. W. & Byrne, L. W. 1913.1. — *Arctic regions.* Lütken, C. F. 1876.1, 1877.2. — *Synopsis.* Lütken, C. F. 1892.1. — *Key to genera.* Zugmayer, E. 1913.2.

Chauliodus. *Occurrence — On Spanish coast.* Odón de Buen, D. 1902.1. — *On Georges Banks, Newfoundland.* Putnam, F. W. 1874.7.

Taxonomy. Bleeker, P. 1862.1.

Maurolicus. *Description of specimen taken in Gulf of Genoa.* Damiani, G. 1896.5.

Sub-family Sternoptychinæ

Taxonomy. — Mediterranean forms. Damiani, G. 1896.5. — *Taxonomy and synonymy.* Gill, T. N. 1885.2. — *Irish waters.* Holt, E. W. L. & Byrne, L. W. 1913.1. — *Arctic regions.* Lütken, C. F. 1876.1, 1877.2. — *Synopsis.* Lütken, C. F. 1892.1.

Family Gonorhynchidæ

Taxonomy, fossil forms; Eocene. Cope, E. D. 1885.1, 1886.2; Woodward, A. S. 1896.4.

SUB-ORDER OSTARIOPHYSI

Taxonomy. —*Eventognathi* (*Catostomidæ, Cobitidæ, Cyprinidæ*). Gill, T. N. 1862.14. —*Cyprinoidea* (*Characiformes, Gymnotiformes, and Cypriniformes*). Regan, C. T. 1911.5. —*Revision; African species.* Boulenger, G. A. Add. 1909.1. —*Fossil forms.* Woodward, A. S. 1889.2.

Family Characinidæ

For maps showing the geographical distribution of the Characinidæ, see Boulenger, G. A. 1904.7 (*p.* 576), *and* Meek, A. 1916.1 (*p.* 172).

Taxonomy, general treatises, reviews, and synopses. Kner, R. 1859.2; Müller, J. & Troschel, F. H. 1844.1, 1845.1; Reinhardt, J. T. 1866.1; Steindachner, F. & Kner, R. 1859.1. —*Annotated list of specimens in U. S. Nat. Mus.* Eigenmann, C. H. & Ogle, F. 1907.1. —*Species in Philad. Acad.* Fowler, H. W. 1906.4. —*South American species.* Eigenmann, C. H. 1907.1; Lütken, C. F. 1874.1, 1875.1; Ulrey, A. B. (*Brazilian*) 1895.1; Steindachner, F. (*Amazonian*) 1876.1, 1877.1. —*Differential characters of Characinoids and Erythrinoids.* Gill, T. N. 1896.1. —*Revision of the genera Chalceus, Copeina, Pogonocharax, and Pyrrhulina.* Regan, C. T. 1912.20. —*Revision; African species.* Boulenger, G. A. Add. 1909.1.

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Sub-family Erythrininæ

Taxonomy; review. Eigenmann, C. H. & R. S. 1889.9.

Sub-family Hydrocyoninæ

Alestes. *List of species.* Boulenger, G. A. 1901.13.

Chirodon. — *Taxonomic revision of South American species of Chirodon and related forms.* ★Eigenmann, C. H. 1915.1. —*Synopsis.* Ulrey, A. B. 1895.1.

Megalobrycon. *Taxonomy; revision.* Ribeiro, A. de M. 1905.1.

Tetragonopterus *and allied forms. Taxonomy* —*Guiana.* Durbin, M. L. 1909.1. —*Brazil.* Eigenmann, C. H. 1908.1, 1911.3.

Nomenclature. Gill, T. N. 1896.6.

Sub-family Serrasalmoninæ

Piranhas or Caribas

For Serrasalmoninæ attacking men, see under Predatory Fishes.

South American species. Eigenmann, C. H. 1915.2. —*Habits and modes of capturing.* Paez, R. 1862.1. —*Popular account.* Winkler, T. C. 1858.1.

Sub-family Distichodontinæ

Distichodus. *List of species.* Boulenger, G. A. 1901.14.

Sub-family Citharininæ

Curimatus *and allied forms. Taxonomy; revision.* Eigenmann, C. H. & R. S. 1889.10.

Family Gymnotidæ

For a map showing the distribution of the Gymnotidæ, see Meek, A. 1916.1 (*p.* 172).

Taxonomy. —*Revision.* Eigenmann, C. H. & Ward, D. P. 1905.1. —*Monograph.* ★Ellis, M. M. 1913.1. —*Place in system.* Fritsch, G. T. 1878.1. —*Synopsis.* Kaup, J. J. 1856.7. —*Argentine species.* Lahille, F. 1910.2. —*Species in Vienna Museum.* Steindachner, F. 1868.1. —*Amazonian forms.* Wallace, A. R. 1853.1.

Phylogeny and manner of life. Schlesinger, G. 1910.1.

Gymnotus (*Electric Eel*). *Natural history, descriptions, mode of capture, etc.* Bajon, – 1774.1, 1779.1; Broussonet, P. M. 1782.2; Bryant, W. 1786.1; Fahlberg, S. 1801.1; Flagg, H. C. 1786.1; Fritsch, G. T. 1879.1; Garden, A. 1775.1; Guisan, F. L. 1797.1, 1819.1; Harting, P. 1880.5; ★Humboldt, F. & Bonpland, A. 1805.1, 1820.1; Hunter, J. 1775.1; Janin de St. Just, – 1821.1; Linden, C. 1879.1; Lindes, L. 1880.1; Musschenbroeck, P. 1760.1; Paez, R. 1863.1; Quelch, J. J. 1897.1; Samo, J. 1837.1; Anon. 186; Gronovius, L. T. Add. 1758.1; Schilling, G. W. Add. 1769.1, Add. 1770.2.

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For anatomy and functions of electrical organs, see under Electrical Fishes.

Family Cyprinidæ

For a map showing the geographical distribution of the Cyprinidæ, see Meek, A. 1916.1 (*p.* 172).

For all hybrid forms, see under Hybrids.

Natural history. Leonhardt, E. E. 1903.3; Neydeck, K. J. 1848.1.

Nomenclature. Bleeker, P. 1863.14.

Taxonomy, affinities, and distribution. Agassiz, J. L. 1835.7,.8; ★Gill, T. N. 1907.1,.4; Heckel, J. J. 1836.1.

Taxonomy of African species; revision. Boulenger, G. A. Add. 1909.1.

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Taxonomy of Cyprinidæ in Europe. Bonaparte, C. L. 1845.1,.3; ★Dybowski, B. I. 1864.1; Fitzinger, L. J. 1874.1,.2; Heckel, J. J. 1836.3. —*Switzerland.* Agassiz, J. L. 1834.2; Fatio, V. 1876.2, 1877.2. —*France.* Quincy, C. 1910.1.

Taxonomy of Cyprinidæ in North America. Jordan, D. S. 1877.1, 1886.1. — *New Jersey.* Abbott, C. C. 1874.4. — *Pennsylvania.* Cope, E. D. 1869.4; ★Fowler, H. W. 1908.3. — *Researches upon the cyprinoid fishes inhabiting the fresh-water west of the Mississippi Valley.* Girard, C. F. 1857.7.

Sub-family Catostominæ

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Sub-family Cyprininæ

Abramis (*Bream*). *Natural history and occurrence.* Bücker, F. 1869.1; Gunn, T. E. 1879.2; Keene, J. H. 1879.5; Lönnberg, A. J. 1903.8; Mela, A. J. 1883.3. — *in Bavaria.* Surbeck, G. 1908.4. — *in Austria.* Rozwadowski, J. 1902.1.

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Barbus. *Natural history, occurrence (in Europe), etc.* Clément, C. 1875.1; Forel, F. A. 1906.1; Günther, A. C. 1872.4; Herrmann, W. 1904.1; Hitz, – 1894.1; Mourgue, M. 1901.1; Olivier, E. 1914.1; Stansch, K. 1904.1; Witthalm, L. 1880.1; Anon. 83. — *In Switzerland.* ★Hofer, J. 1895.2. — *In Silesia.* Knauthe, K. 1890.2. — *Alps of Dauphiné.* Légar, L. 1910.4.

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Culture of Lion-head variety. Laackmann, H. 1911.1; Thumm, J. 1911.1.

Culture of Telescope variety. Carbonnier, P. 1872.2,.3, 1873.3; Delaval, A. 1899.1, 1903.1; Depp, N. 1894.1; Frank, F. 1880.1; Langer, – 1877.1; Lee, H. 1875.1; Newman, E. 1875.1; Nitsche, P. 1892.1; Noll, F. C. 1878.1; Sasse, A. 1878.1; Schreitmüller, W. 1912.14,.18, 1913.2.

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Natural history notes in Pre-Linnæan section. Ledel, S. 1692.1; Linnæus, C. 1744.1; Needham, W. 1720.1; Nozeman, C. 1757.1.

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1903.1; Corbin, G. B. 1906.1; Hofer, J. 1911.5; Keene, J. H. 1879.5; Kirsch, D. W. 1880.1; Lupton, F. 1878.1; Milde, C. J. 1873.1; Solger, B. F. 1878.1; Warnimont, J. 1865.1.

Taxonomy and nomenclature. Bonaparte, C. L. 1840.1, 1844.1. —*Nomenclature.* Cockerell, T. D. 1909.2.

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For incubation of eggs in gill-cavities of mussels, see Parental Care, *under* Reproduction.

Sub-family Cobitidinæ

Taxonomy. Bleeker, P. 1863.23. —*Amur basin.* Berg, L. S. 1907.11. —*Ceylon.* Bleeker, P. 1864.2. —*Japan.* Jordan, D. S. & Fowler, H. W. 1903.3.

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For Cobitis as a weather prophet see under Behavior.

Fossil forms in Germany. —*Tertiary.* Meyer, C. E. H. 1851.2. —*Miocene.* Winkler, T. C. 1861.1.

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Family Siluridæ

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Sub-family Clariinæ

Taxonomic revision, African species. Boulenger, G. A. 1908.9.

Sub-family Silurinæ

Silurus glanis (*the Wels*). *Natural history and occurrence in Central Europe.* Feddersen, A. F. 1896.2; Fougeroux de Bondaroy, – 1784.1; Hofer, B. 1906.1; Hofer, J. 1896.2; Holm, T. 1779.1; Lubach, D. 1852.1, 1864.1; Lühe, M. 1909.1, 1912.1; Meier, H. 1865.2; Malmgren, A. J. 1888.1; Mela, A. J. 1883.2; Plant, J. 1878.1, 1879.1,.2; Reinhardt, J. T. 1865.1; Spohrer, – 1897.1; Winkler, T. C. 1871.3; Anon. 194, 627; Imhof, O. E. Add. 1892.1.

Parasilurus (*the Glanis of the Greeks and Romans*). *Natural history.* Apostolidès, N. C. 1883.1, 1892.1; Bleeker, P. 1862.6; ★Gill, T. N. 1906.4; Houghton, W. 1873.1; Garman, S. Add. 1891.3; Manardi, G. Pre-Linn. 1560.1.

Sub-family Bagrinæ

Arius. *Fossil forms in Tertiary of Siwaliks.* Günther, A. C. 1881.3. —*in Eocene of France.* Priem, F. 1904.3. —*in Eocene of Belgium.* Smets, G. Add. 1886.1.

Amiurus (*Bull-head*). *Natural history.* Berthier, V. 1905.1; Dean, B. 1891.1;

Good, A. 1902.1; Lamarche, C. 1904.1; Leonhardt, E. E. 1905.25.

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Noturus (*Stone Cat-fish*). *Taxonomy; review.* Swain, J. & Kalb, G. B. 1882.1.

Pimelodus. *Taxonomy; synopsis.* Gill, T. N. 1862.23.

Sub-family Doradinæ

Taxonomy. —*African species.* Boulenger, G. A. 1900.14. —*Brazilian species.* Ribeiro, A. 1912.1; Steindachner, F. 1875.4.

Exostoma. *Taxonomy; synopsis.* Regan, C. T. 1905.17.

Synodontis. *Taxonomy; monograph.* ★Vaillant, L. L. 1895.1.

Sub-family Malopterurinæ

Malopterurus (*Electric Cat-fish*). *Natural history.* Forbes, H. O. 1897.3; Kammerer, P. 1906.1; Panceri, P. 1858.1; Peters, W. C. 1868.2; Rudolphi, C. A. 1824.1; Waddell, H. M. 1858.1; Broussonet, P. M. Add. 1787.1; Patterson, W. Add. 1786.1; Adanson, M. Pre-Linn. 1749.1; Ludolf, H. Pre-Linn. 1681.1.

History of discovery. Du Bois-Reymond, E. H. 1859.2.

Nomenclature. Gill, T. N. 1903.9.

For anatomy and functions of electrical organs, see under Electrical Fishes.

Sub-family Callichthyinæ

Taxonomy. Ellis, M. L. 1913.1. —*Brazil.* Ribeiro, A. de M. 1912.1.

Corydoras. *Taxonomy; revision.* Regan, C. T. 1912.21.

Sub-family Trichomycterinæ

Taxonomy; Brazil. Ribeiro, A. de M. 1912.1.

For parasitic habits of fishes of this sub-family, see under Parasitic Fishes.

Stegophilus. *Natural history and systematic position.* Rachow, A. 1913.5; ★Reinhardt, J. T. 1859.1.

Vandellia (“*Candiru*”). *Taxonomy; revision.* Pellegrin, J. 1909.12.

Family Loricariidæ

Natural history. Weyenbergh, H. 1878.3.

Taxonomy. Eigenmann, C. H. 1905.3. —*Revision.* Kner, R. 1854.1,.2. —*Monographic revision.* ★Regan, C. T. **1904.6.** —*Brazilian forms.* Ribeiro, A. de M. 1912.1.

Acanthicus. *Natural history.* Berg, C. 1901.1; Hagmann, G. 1901.1, 1902.1.

Arges. *Natural history of the “volcano fish” formerly called Cyclopium cyclopium, Eremophilus mutisii, and Pimelodus cyclopum.* Boussingault, J. B. 1864.1; Day, F. 1891.1; ★Evermann, B. W. & Kendall, W. C. 1905.1; Girard, C. F. 1889.1, Add. 1889.2; ★Humboldt, F. & Bonpland, A. 1805.1; Orton, J. 1871.1; Putnam, F. W. 1871.3; Spicer, W. W. 1871.2; Wagner, M. 1870.2; Winkler, T. C. 1857.2; Humboldt, A. Add. 1823.1; Whymper, E. Add. 1892.1.

Taxonomy; revision. Evermann, B. W. & Kendall, W. C. 1905.1; Regan, C. T. 1905.18.

Family Aspredinidæ

Taxonomy and relationships. Gill, T. N. 1891.3.

Group Nematognathi

This group, formerly given ordinal rank, embraces the Siluridæ, Loricariidæ, and Aspredinidæ.

Taxonomy and relationships. Agassiz, J. L. R. 1868.1; Regan, C. T. 1911.6; Gill, T. N. Add. 1898.1. —*South American forms.* ★Eigenmann, C. H. & R. S. 1888.4,.5, 1889.3, **1890.3**; Ihering, R. (*Brazil*) 1907.1; Kindle, E. M. (*in Cornell Museum*) 1895.1.

Evolution. Eigenmann, C. H. 1890.4.

Fossil forms from Eocene. Newton, E. T. 1889.1. —*Egypt.* Stromer, E. 1904.3.

SUB-ORDER SYMBRANCHII

For a map showing the geographical distribution of the Symbranchii, see Meek, A. 1916.1 (*p.* 166).

Taxonomy. Regan, C. T. 1912.1; Boulenger, G. A. (*Revision, African species*) Add. 1909.1.

Family Symbranchidæ

Taxonomy, Indian Archipelago. Bleeker, P. 1853.4, 1862.1. —*General account.* Dareste, C. 1873.1,.2.

Monopterus. *Taxonomy; review, Japan.* Jordan, D. S. & Snyder, J. O. 1901.7.

SUB-ORDER APODES

Taxonomy; general works. Gill, T. N. 1910.1; Kaup, J. J. 1856.1; Regan, C. T. 1912.15. —*Review; America and Europe.* Jordan, D. S. & Davis, B. M. 1892.1. —*Review; Japan.* Jordan, D. S. & Snyder, J. O. 1901.7. —*Indian forms.* M'Clelland, J. 1845.1. —*African species.* Boulenger, G. A. Add. 1909.1. —*Fossil forms.* Woodward, A. S. 1889.2.

FAMILY ANGUILLIDÆ

ANGUILLA

The Common or Fresh-water Eel

Including an account of the recent discoveries in its life history and reproduction.

The literature on the eel is relatively enormous, and the present account attempts to suggest the more important references, rather than to attempt to analyze them in detail.

“The problem of the propagation and breeding places of the Common or Fresh-water Eel is one of great antiquity; from the days of Aristotle naturalists have occupied themselves therewith, and in certain regions of Europe it has exercised popular imagination to a remarkable degree. It is only during the last three decades, however, that any real results have been attained.” J. Schmidt *in*

"The Breeding Places of the Eel," Phil. Trans. Roy. Soc. London, 1922, ser. B., vol. 211, p. 179.

Principal literature

Our knowledge of the life history of the eel is largely due to the brilliant and extended researches of Dr. Johannes Schmidt of the Carlsberg Laboratory of Copenhagen (cited as Schmidt, E. J. 1906.1–1914.2). These papers are chiefly in English and have been embellished with excellent illustrations of all stages of development. These researches have been summarized in two general papers one of which is cited as ★Schmidt, E. J. **1906.1**, and the other is the very recent paper, quoted above.

For a map showing the geographical distribution of the genus Anguilla, see Meek, A. 1916.1 (*p.* 158).

Life history of the Eel

Because of the very lateness of these discoveries, which have not yet entered fully into general ichthyological literature, we feel justified in giving the following somewhat extensive summary, compiled chiefly from the papers just mentioned (especially Schmidt, 1906.1).

The first Leptocephalus to come to the attention of naturalists seems to be the specimen taken by William Morris near Holyhead, England in 1763 and subsequently described by Gmelin (J. F. 1788.1, p. 1150) as *Leptocephalus morrisii.* Subsequently numerous other specimens of these small, translucent or glassy, ribbon-like creatures, brought to the surface by the whirlpools in the Straits of Messina, came into the hands of naturalists and were known under the family name of Leptocephalidæ (Bonaparte).

Carus (J. V. 1861.2), in considering these fishes, recognized their true nature as larval forms, and assumed that they were probably the larval form of the ribbon fishes (Trachypteridæ). This conclusion was shown to be erroneous by Peters (W. 1869.2), who demonstrated that larval ribbon fishes were quite different.

Gill (T. N. 1865.9) had just expressed the view that the Leptocephali are the larvæ of eels ("Congers"), and that *Leptocephalus morrisii* is the young of the conger eel. This conclusion was also reached independently by Dareste (C. 1873.3). Günther (A. 1859.1, vol. viii, 1870, 1880.4) accepted Gill's view, but thought that they were abnormally developed conger larvæ, which view was likewise accepted by Bellotti (C. Add. 1883.1).

The actual proof of Gill's view was first made by Delage (M. Y. 1886.1) who kept a specimen of *L. morrisii* in the aquarium of the Roscoff laboratory and observed its transformation into a small conger, 9.3 cm. in length.

The way was now paved for the discovery of the larval form of the common eel. Kaup (J. J. 1860.4) had previously described one of the Mediterranean Leptocephali as *Leptocephalus brevirostris.* In 1893, the epoch-making discovery that this form is the larval form of the common eel, *Anguilla vulgaris*, was announced by Grassi and Calandruccio (1892.1–1903.1), who had found the necessary transitional stages.

Not until 1904 had any Leptocephali of the common eel been observed outside of the Mediterranean. In this year Schmidt (1904.1) took a Leptocephalus of the European eel west of the Faroe Islands. A second specimen was taken on the west coast of Ireland in 1904 by Farran (Holt, E. W. 1909.1). Subsequently numerous larvæ were found in the northeastern Atlantic. Jacoby (L. 1867.1–1882.1) believed the breeding ground to be off the coast in deep water. Schmidt (E. J. 1909.5) found the south Atlantic to be devoid of Leptocephali. Hjort (J. 1910.1) and Lea (E. 1913.2) suggested that the breeding grounds would be found in the central Atlantic between the Azores and the Bermudas. Schmidt, from investigations in the open Atlantic in the schooner "Margrethe," 1913, and with over 500 gatherings made for him on board various coöperating Danish ships, found that the Leptocephali increased in number but decreased in size as he went from Europe toward the West Indies. Small sizes were found concentrated in a comparatively small area, extending from 22° N. to 30° N. and from 40° W. to 65° W.; the central portion lying about latitude 26° N. or approximately equidistant from the Leeward Isles and from Bermuda. This is the breeding place of the eel. At this point the smallest larvæ were found concentrated in considerable numbers. In his most recent paper ("The Breeding Places of the Eel," etc. p. 206), Schmidt has summarized the breeding habits of the eel as follows:

> "Spawning commences in early spring, lasting to well on in summer. The tiny larvæ, 7–15 mm. long, float in water-layers about 200–300 metres from the surface, in a temperature of about 20° C. The larvæ grow rapidly during their first months, and in their first summer average about 25 mm. in length. They now move up into the uppermost water-layers, the great majority being found between 50 and 25 metres, or at times even at the surface itself. Then they commence their journey towards the shores of Europe, aided by the eastward movement of the surface-water itself. During their first summer, they are to be found in the western Atlantic (west of 50° long. W.). By their second summer they have attained an average length of 50–55 mm., and the bulk are now in the central Atlantic. By the third summer, they have arrived off the coastal banks of Europe and are now full-grown, averaging about 75 mm. in length, but still retaining the compressed leaf-shaped larval form. In the course of the autumn and winter, they undergo the retrograde metamorphosis which gives them their shape as eels and brings them to the elver stage, in which they move in to the shores and make their way up rivers and watercourses everywhere. . . . The eels utilise their sojourn in fresh water to feed and grow big, but the duration of their

stay here varies greatly, according to sex, climate and quantity of food, ranging from about 5 to about 20 years or more. All the large eels are females; the males seldom exceed 45 cm. in length."

The Leptocephalus of the American eel (*Anguilla rostrata*) was first described by Eigenmann & Kennedy (1902.1) as *L. grassi*. It is distinguished from that of the European eel (*A. vulgaris*) by the smaller number of myomeres, and in the adult by the smaller number of vertebræ.

Schmidt found that the breeding grounds of the American species lie along the entire range north of the West Indies, with their central portion lying west and south of the central breeding grounds of the European eel. Therefore the two grounds overlap and the larvæ of the two species are intermingled in the mid-Atlantic. Schmidt says (Phil. Trans. Roy. Soc. 1922, p. 204):

"How do the masses of larvæ in the western Atlantic sort themselves out, so that those individuals which belong to *Anguilla vulgaris* ultimately find themselves in Europe, while those of *Anguilla rostrata* 'land' on the shores of America and the West Indies?"

"In the main, the question is no longer difficult to answer. In the case of the American eel, the pelagic larval stage is terminated in about one year; consequently the larvæ have not time to make the journey to Europe, the distance being more than they can cover in that period. It is otherwise with the European eel, which takes nearly three times as long over its larval development, as a result of which practically all of them are far away from the western (American) portion of the Atlantic when the time comes for them, as elvers, to seek the coasts."

Young eels (elvers), during their ascent of streams, will follow up the smallest trickle of water. The following papers record the obstruction of water pipes in this way. Bean, B. A. 1892.3; Bishop, W. L. 1908.1; Nye, W. 1883.1.

Capture of adult eels in the open sea. Cligny, A. 1912.1,.6; Vaillant, L. L. 1898.3,.5.

Marking experiments, chiefly in Finland, with adult eels to determine the rate of seaward migrations. Nordqvist, O. F. 1903.3, .6, 1904.1,.2,.3; Schneider, G. 1904.10, 1905.9, 1908.4; Trybom, F. & Schneider, G. 1908.1,.2,.3.

Sexes of the Eel

Because of the location of their breeding ground, the capture of sexually mature eels has been infrequent. The following historical resumé, with necessary insertion of citations, is quoted from Schmidt (E. J. 1906.1, p. 138).

"The Italian Mondini (C. 1783.1) first described the ovary or female genital organ of the eel in 1777, and the Dane O. F. Müller independently in 1780. The correctness of the determination was confirmed in 1838 by the German Rathke (M. H. 1838.1), who later in 1850 (1850.1) further described a female eel, in the ovary of which he could detect eggs 1/10 millimeter in diameter. Between Mondini's discovery in 1777 of the female genital organs and the discovery of the male organs a period of a hundred years elapsed. The reason for this may be found partly in the fact, that no one had noticed the peculiarity that the male eels are considerably smaller than the females, and the males were consequently being sought for amongst the large eels without result. In 1874 the Austrian Syrski (S. 1874.2, 1875.1,.2, 1876.1) first described the male organ of the eel, and this has very often in consequence been called 'Syrski's organ,' or on account of its fold-like appearance the 'lobed organ.' Syrski's observations were later confirmed and amplified by a number of observers in various countries."

Other papers recording male or female eels; relating to the state of their reproductive organs, or dealing with their sexual dimorphism. ★Balsamo-Crivelli, G. & ★Maggi, L. 1872.1,.2, 1873.1; Barfod, H. 1902.4; Calderwood, W. L. 1893.2; Cattie, J. T. 1880.1; Cunningham, J. T. 1895.9; Freud, S. 1877.1; Feddersen, A. F. 1893.1, 1894.1; Giacomini, E. 1908.1; Gill, T. N. 1881.3; H. 1893.1; Hermes, O. 1880.2, 1881.1; Joly de Sailly, – 1907.1; Kingsley, J. S. 1879.1; Lepori, C. 1883.1; ★Mazza, F. 1912.1, **1913.1**; Möbius, K. A. 1887.1; Münter, J. A. 1873.1; Packard, A. S. 1879.2; Packard, A. S. & Kingsley, J. S. 1879.1; Pavesi, P. 1880.1, 1887.2; Putnam, F. W. 1878.1; Rauber, A. 1875.1; Ritsema, C. 1875.1; Robin, C. P. 1881.1; Ryder, J. A. 1885.5; Sawyer, J. G. 1879.1; Schmidt, F. 1874.1; Trybom, F. 1902.3; Schluesser, G. Add. 1848.1; Anon. 353.

Hermaphroditism. Ercolani, G. B. 1871.1, 1872.1,.2; Nardo, G. D. 1871.2; Anon. 7.

Various Leptocephali

Occurrence of Leptocephalus brevirostris, larval form of the European eel, in waters of the North Atlantic and about the British Isles. Bowman, A. 1913.1; Herdman, W. A., Scott, A. & Johnstone, J. 1899.1; Hillas, A. B. 1910.1; Hjort, J. 1910.1; Holt, E. W. 1908.1, 1909.2; Petersen, C. G. 1905.1; Schmidt, E. J. 1909.4; Lea, E. Add. 1913.1.

Occurrence of Leptocephalus morrisii, larval form of the conger eel, in British waters. Cunningham, J. T. 1891.8, 1893.5, 1895.4, 1897.2; Edwards, T. 1878.1; Fulton, T. W. 1904.1, 1905.2; Gilson, G. 1908.2; Deere, H. V. Add. 1833.1.

Various papers describing new species of Leptocephalus, or other taxonomic notes, Leptocephali of various regions, etc. This list is assumed to be incomplete. Blegvad, H. 1913.1; Haast, J. F. 1875.2; Kölliker, R. A. 1853.1; Pappenheim, P. 1914.1; Peters, W. C. 1859.1, 1865.1; Schmidt, E. J. 1910.1; Steindachner, F. 1870.3; Storer, D. H. 1848.2; ★Strömman, H. 1896.1; Bellotti, C. Add. 1883.1; Facciolà, L. Add. 1883.1,.2, 1885.1; Schmidt, J. 1912.1.

General Literature

The principal literature and the important steps in the development of our knowledge concerning the breeding habits and life history of the eel have been detailed above. The following citations include the great bulk of other references to the life history, breeding and feeding habits, migrations, etc. which in general, however, do not present original important contributions. Most of these papers refer to the European eel.

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Numerous references to the Leptocephali of the Conger, formerly confused with larval stages of the common eel, will be found above under Anguilla.

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Family Saccopharyngidæ

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Family Chirothricidæ

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Family Kneridæ

Taxonomy. Gill, T. N. 1903.1.

Group Microcyprini

Comprising Amblyopsidæ and Cyprinodontidæ

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Family Cyprinodontidæ (Pœciliidæ)

For ovarian reproduction in Pœciliidæ, see Viviparity, *under* Reproduction.

For maps showing the distribution of the Cyprinodontidæ, see Boulenger, G. A. 1904.7 (*p.* 617), *and* Meek, A. 1916.1 (*p.* 184).

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Family Amblyopsidæ

The Cave-fishes

For a map showing the distribution of the Amblyopsidæ, see Meek, A. 1916.1 (*p.* 184).

For other fishes with degenerate eyes, see Blind fishes of the Caves.

Various notes on Amblyopsidæ. Eigenmann, C. H. 1899.1,.4,.5,.8, 1900.1,.2; Forbes, S. A. 1882.1; Girard, C. F. 1888.1,.2; Putnam, F. W. 1872.1,.2, 1875.1,.2.

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Amblyopsis. *Ear and hearing.* Eigenmann, C. H. & Yoder, A. C. 1899.1; Payne, F. 1909.1; Wyman, J. 1854.5.

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Chologaster (*An eyed member of the Amblyopsidæ*). Agassiz, J. L. 1853.6; Eigenmann, C. H. 1899.3; Putnam, F. W. 1880.1.

Troglichthys rosæ (*Eigenmann*) (*A markedly degenerate Amblyopsid from caves of Missouri*). Eigenmann, C. H. 1897.3, 1899.2; Garman, S. 1889.1.

Typlichthys subterraneus (*Girard*) (*An Amblyopsid from Kentucky caves*). Eigenmann, C. H. 1899.2; Girard, C. F. 1859.2; 1888.1,.2; Putnam, F. W. 1872.1,.2, 1875.1,.2.

Family Stephanoberycidæ

Original description. Gill, T. N. Add. 1884.2.

Family Percopsidæ (Salmopercæ)

For a map showing the distribution of the Percopsidæ, see Meek, A. 1916.1 (*p.* 184).

Taxonomy. Eigenmann, C. H. (*Pacific slope, U. S. A.*) 1892.9; Regan, C. T. 1911.3.

SUB-ORDER HETEROMI

Taxonomy; revision. Goode, G. B. & Bean, T. H. 1894.3.

Family Dercetidæ

Structure and taxonomy, Cretaceous. Woodward, A. S. 1889.2.

Family Halosauridæ

Taxonomy. Gill, T. N. 1889.2.

Family Notacanthidæ

Taxonomy. Bleeker, P. (*Sunda-Molucca Archipelago*) 1850.4; Gill, T. N. 1889.4.

Family Fierasferidæ

Fierasfer (**Echidion, Lefroyia, Oxybeles,** *syns.*). *General treatise.* ★Emery, C. **1880.1,.2**.

Natural history, including references to symbiotic habits and larval forms (**Encheliophis** *and* **Vexillifer**). Costa, A. 1871.2; Emery, C. 1879.1 (iii), 1879.2 (i); Kaup, J. J. 1856.4, 1860.4; Putnam, F. W. 1874.4. —*For association with echinoderms, pearl oysters, and tunicates, see also under* Commensalism and Symbiosis.

Occurrence. —*In East Indies.* Bleeker, P. 1851.18, 1854.17, 1858.14. —*In Norwegian waters.* Collett, R. 1882.1. —*In Scotland.* Edwards, T. (*Banff*) 1863.2; Sim, G. (*Aberdeen*) 1883.3. —*In Ireland.* Thompson, W. 1837.1.

SUB-ORDER CATOSTEOMI

"*Limits and contents*" *of the group.* Boulenger, G. A. 1901.15.

DIVISION SELENICHTHYES

Family Lamprididæ

Taxonomy. Gill, T. N. 1903.8; Regan, C. T. 1907.11. — *Australian forms.* Kershaw, J. A. 1913.1.

Lampris. *Natural history.* Fulton, T. W. 1901.1, 1902.1, 1903.2; Holten, H. S. 1902.1; Katuric, M. 1902.1; Morton, A. 1897.1; Shufeldt, R. W. 1893.2.

Occurrence. — *on British coast.* Clarke, J. B. (*Shetland*) 1905.1; Cornish, T. (*Cornwall*) 1865.1; Gray, J. E. 1861.2. — *in California.* Evermann, B. W. 1896.2. — *on Dutch coast.* Lidth de Jeude, T. W. 1889.1. — *on Murman Coast.* Lönnberg, A. J. 1900.4. — *in New Zealand waters.* Waite, E. R. 1899.2. — *on the Grand Banks.* Jordan, D. S. Add. 1889.2.

Taxonomy and relationships. Boulenger, G. A. 1901.15; Brünnich, M. T. 1788.2; Retzius, A. J. 1799.1; Gill, T. N. Add. 1903.4. — *Earliest description.* Mortimer, C. Pre-Linn. 1750.1.

DIVISION HEMIBRANCHII

Taxonomy; — *Synopsis.* Gill, T. N. 1885.3. — *Review, Japan.* Jordan, D. S. & Starks, E. C. 1903.4. — *Fossil forms.* Woodward, A. S. 1889.2.

Family Gasterosteidæ

The Sticklebacks

For a map showing the geographical distribution of the Gasterosteidæ, see Boulenger, G. A. 1904.7 (*p.* 631).

Taxonomy. — *Review; American species.* Eigenmann, C. H. 1887.2. — *Nova Scotia.* Girard, C. F. 1857.5.

Fossil forms. — *In Pleistocene of Nevada.* Hay, O. P. 1907.1. — *Taxonomy.* Jordan, D. S. 1907.3, 1908.2.

Gasterosteus. *Natural history notes, popular articles, etc.* Borcéa, J. 1904.4; Forbes, H. O. 1897.2; Leonhardt, E. E. 1907.2; Lönnberg, A. J. 1898.2; Lühe, M. 1911.1; Martens, E. 1871.1; O., - 1830.1; Ramage, J. 1825.1, 1826.1; Salm-Horstmar, W. F. 1860.1; Schulze, L. 1915.3; Seligo, A. 1901.1; Sprenger, W. 1901.4; ★Swinnerton, H. H. 1907.1; Anon. 320, 430, 459, 509; Holt, E. W. Add. 1893.2; Kendall, W. C. Add. 1902.1; Arderon, W. Pre-Linn. 1748.2; Westbeck, Z. Pre-Linn. 1754.1.

Taxonomy. — *Revisions.* Regan, C. T. 1909.15; Sauvage, H. E. 1874.5. — *Species of Ireland.* Thompson, W. 1841.4.

Variability and variations. Bonizzi, P. 1869.2; Boulenger, G. A. (*in lateral shields*) 1893.3; Day, F. 1878.3; Harting, P. 1878.4; Lunel, G. (*of diagnostic characters*) 1882.1; Mourgue, M. 1901.3.

For a map showing the distribution of members of the genus Gasterosteus, see Meek, A. 1916.1 (*p.* 188).

Pygosteus. *Review East Asian forms.* Berg, L. S. 1907.12.

For a map showing the geographical distribution of species of the genus Pygosteus, see Meek, A. 1916.1 (*p.* 190).

Spinachia. *Natural history.* Petersen, C. G. 1893.5.

For a map showing the distribution of Spinachia, see Meek, A. 1916.1 (*p.* 194).

Family Aulorhynchidæ

For a map showing the geographical distribution of the Aulorhynchidæ, see Meek, A. 1916.1 (*p.* 194).

Taxonomy. Gill, T. N. 1863.12.

Family Centriscidæ

Macrorhamposidæ, syn.

Taxonomy; synopsis. Regan, C. T. 1914.10.

Centriscus (Macrorhamposus) (*Snipe-fish*). *Natural history and occurrence.* Emery, C. 1879.2 (5); Künstler, J. & Chaine, J. 1906.1; Rodier, E. 1898.1. — *On French coast.* Brasil, L. & Gadeau de Kerville, H. 1905.1. — *On Chilean coast.* Delfin, F. T. 1899.4. — *In Irish waters.* Patterson, R. 1906.1. — *In Florida waters.* Smith, H. M. 1904.7.

Taxonomy. — *Revision.* Weber, M. C. 1909.3.

Family Amphisilidæ

Amphisile. Taxonomy and occurrence. Hilgendorf, F. M. 1884.1; Lütken, C. F. (*synopsis*) 1865.1. — *Palau Is.* Macleay, W. 1879.3.

Group Lophobranchii

(Hippocampids and Syngnathids)

Natural history. Duncker, G. 1900.1; Harting, P. 1872.5; Noll, F. C. 1879.1; Zograf, N. Y. 1901.4.

Taxonomy. Cope, E. D. 1871.9; Gill, T. N. 1896.2; Hollard, H. L. 1850.1; ★Kaup, J. J. 1853.1, **1856.2**; Nardo, G. D. 1842.1. — *Review, Japan.* Jordan, D. S. & Snyder, J. O. 1901.11.

Family Syngnathidæ

Pipe-fishes and Sea-horses

Taxonomy — *of Genera.* ★Duncker, G. 1912.1. — *Australian forms.* Duncker, G. 1909.1. — *Indian forms.* Duncker, G. 1910.1. — *Synopsis; western North America.* Gill, T. N. 1863.24. — *Baltic Sea.* Heincke, F. 1880.1. — *Review of American species.* Swain, J. 1882.3.

Hippocampus (*Sea-horse*). *Natural history notes; miscellaneous accounts, descriptions, etc.* Baird, S. F. 1872.17; Bert, P. 1867.3; Brittain, T. 1873.1; Dax, L. 1863.1; ★Gill, T. N. 1905.5; Goode, G. B. (*on St. Georges Banks*) 1878.8; Hutchinson, T. N. 1873.1; Shufeldt, R. W. 1895.1; Anon. 499. — *Tail as a prehensile organ in Hippocampus.* Dufossé, A. 1874.2.

Early descriptions, figures, etc. of the sea-horse. Osburn, R. C. 1915.1; Anon. 730; Eastman, C. R. Add. 1916.2, Add. 1917.4; Moffett, T. Pre-Linn. 1634.1.

Nerophis. *Natural history, occurrence, etc.* Lord, J. K. 1867.4; Smith, John A. 1863.2-.4. — *In Ireland.* Barrett-Hamilton, G. E. 1892.1. — *Pelagic form.* Ever-

mann, B. W. & Kendall, W. C. 1908.1. — *In Finland.* Nordqvist, O. F. 1899.8. — *Off British coast.* Holt, E. W. L. & Byrne, L. W. 1904.1. — *Off Scotland.* Young, W. S. 1863.1.

SUB-ORDER PERCESOCES

Structure and taxonomy, fossil forms. Woodward, A. S. 1889.2.

Family Scombresocidæ

Taxonomy. Gill, T. N. 1896.3; Regan, C. T. 1911.7. — *Dutch E. Indies.* Bleeker, P. 1862.1. — *Review, American species.* Jordan, D. S. & Fordice, M. W. 1887.1. — *Review, Japan.* Jordan, D. S. & Starks, E. C. 1903.5. — *Revision, African species.* Boulenger, G. A. Add. 1909.1.

Phylogeny and ecology. Schlesinger, G. 1909.2.

Belone (*Gar-fish*). *Natural history, popular accounts, descriptions, etc.* Bianchi, V. 1907.1; Hutchinson, H. G. 1904.1; Anon. 298, 445; Gill, T. N. Add. 1895.1; Martini, F. H. Add. 1775.1; Schoepf, J. D. Add. 1776.1; Jacobaeus, O. Pre-Linn. 1675.1.

Exocœtus (*Flying-fish*). *Natural history notes, descriptions, etc.* Brown, T. 1778.1; Lord, W. B. 1866.1. — *In England.* Murie, J. 1905.1, 1906.1; Patterson, A. H. 1906.2; Stephenson, T. 1894.1.

Taxonomy; revisions. Bleeker, P. (*Indian Archip.*) 1866.12; Jordan, D. S. & Meek, S. E. (*America*) 1886.2; ★Lütken, C. F. 1874.1 (vi), 1877.1,.3; Weinland, D. F. 1856.1.

For structure of pectoral fins of Exocœtus in adaptation for flight, see under Fins, paired.

For flight of Exocœtus, see under Flying fishes and their flight.

Hemirhamphus (*Half-beak*). *Natural history and occurrence.* Andrews, W. 1849.3; Günther, A. C. 1866.3; Malm, A. W. 1852.1; Yarrow, H. C. 1872.1. — *on English coast.* Clarke, W. Barnard 1837.1; Couch, J. 1851.4.

Taxonomy. — *Revision of species of Indian Archip.* Bleeker, P. 1866.10. — *Synopsis of genera.* Gill, T. N. 1864.13. — *Review, American species.* Meek, S. E. & Goss, D. K. 1885.1.

Family Ammodytidæ

Taxonomy. Gill, T. N. 1904.6; Regan, C. T. 1913.2. — *Japanese forms; review.* Jordan, D. S. 1906.1.

Ammodytes (*Sand-eel or Launce*). *Natural history notes, miscellaneous accounts, descriptions, etc.* Bowman, A. 1914.1; Cisternas, R. 1875.1; ★Fullarton, J. H. 1894.1; Jourdain, S. 1879.1; ★Masterman, A. T. 1895.1; Pybus, W. M. 1912.1; Sandman, J. A. 1894.3; Schultén, A. B. 1874.1; Anon. 538; Martini, F. H. Add. 1775.1.

Taxonomy, Finland. Gottberg, G. 1910.1.

Family Atherinidæ

Taxonomy. Fowler, H. W. 1903.3; Machado de Carvalho, G. 1898.1. — *Review, Japan.* Jordan, D. S. & Starks, E. C. 1901.3. — *Australia.* McCulloch, A. R. 1912.2. — *Madagascar.* Pellegrin, J. 1914.5. — *Western Europe.* Roule, L. 1903.4.

Atherina. *General account, European species.* ★Borsieri, C. 1902.2, **1904.2.**

Natural history. Costa, O. G. 1844.2; Krause, E. 1902.1. — *Ovum.* Pagenstecher, H. A. 1861.1. — *Reared in fresh water.* Robertson-Proschowski, A. 1907.1; Roule, L. 1903.3.

Chirostoma. *Occurrence in — Lake Chapala, Mexico.* Boulenger, G. A. 1900.7; Jordan, D. S. 1900.4. — *Chile.* Steindachner, F. 1896.3.

Melanotænia *and related species. Taxonomy, Australia.* Ogilby, J. D. 1896.3; Gill, T. N. Add. 1894.1.

Menidia (*Silverside*). *Notes on species in United States.* Kendall, W. C. 1902.1.

Family Mugilidæ

Taxonomy. Cuvier, G. L. 1830.1; Fowler, H. W. 1903.6. — *British Guiana.* Hancock, J. 1830.1. — *Revision, American marine forms.* Jordan, D. S. & Swain, J. 1885.5. — *Australia.* Macleay, W. 1880.4.

Mugil (*Mullet*). *Natural history notes.* Carazzi, D. 1913.1; Dannevig, H. C. 1902.4; Hancock, J. 1830.1; Lloyd, W. A. 1867.1; Ninni, E. 1909.1.

Family Polynemidæ

Taxonomy. — *Synopsis.* Gill, T. N. 1862.26. — *Review, American species.* Kirsch, P. H. 1890.1.

Family Chiasmodontidæ

Taxonomy and relationships. Gill, T. N. 1883.2.

Chiasmodon (*Swallower*). *Natural history and occurrence.* Carte, A. 1866.1. — *In Madeira.* Johnson, J. Y. 1864.1. — *In Indian Ocean.* Smith, H. M. 1901.1. — *Off Portugal.* Wright, E. P. 1868.1.

Family Sphyrænidæ

Taxonomy. Bleeker, P. (*Indian Archipel.*) 1854.6; Fowler, H. W. 1903.6.

Sphyræna (*Barracuda*). *Taxonomy. Review, American species.* Meek, S. E. & Newland, R. G. 1885.2.

Fossil in Tertiary of Tyrol. Meyer, C. E. H. 1863.2.

For a monograph on the Barracuda, reviewing the literature and giving many photographic illustrations, see E. W. Gudger, "Sphyræna barracuda; its morphology, habits and history." Pub. no. 252, Carnegie Institution, Washington (Papers Tortugas Laboratory, 1918, 55 p. 7 pls.).

Family Tetragonuridæ

Tetragonurus. *Natural history.* Emery, C. 1879.1 (iv).

Taxonomy. Review. Ramsay, E. P. & Ogilby, J. D. Add. 1888.2.

Family Stromateidæ

Taxonomy. Gill, T. N. 1884.2. — *Review, American species.* Fordice, M. W. 1885.1. — *Great Britain.* Holt, E. W. L. & Byrne, L. W. 1903.3. — *Revision.* ★Regan, C. T. 1902.4.

Centrolophus (*Black-fish*). *Natural history and occurrence — off Massachusetts.* Bean, B. A. 1898.2. — *in Gulf of Naples.* Costa, A. 1871.1. — *at New Zealand.* Hutton, F. W. 1904.3. — *in French waters.* Pellegrin, J. 1912.16. — *in Firth of Forth.* Traquair, R. H. 1902.3.

Cubiceps. *Occurrence in Mediterranean.* Ariola, V. 1904.1, 1912.1; Bonaparte, L. C. 1846.1.

Family Icostidæ
" Rag-fishes "

Acrotus. *Occurrence at Port Townsend, Washington.* Bean, B. A. 1898.2; Bean, T. H. 1887.4.

Icichthys. *Occurrence on California coast.* Jordan, D. S. & Gilbert, C. H. 1880.13.

Icosteus. *Description and natural history.* Cohn, L. 1905.1.

Schedophilus medusophagus (*Medusa-eater*). *Natural history and occurrence.* Günther, A. C. (*in Great Britain*) 1885.1; Trois, E. F. 1900.2.

Taxonomy, review. Ogilby, J. D. 1893.3.

Family Ophiocephalidæ

For maps showing the distribution of the Ophiocephalidæ, see Boulenger, G. A. 1904.7 (*p.* 645), *and* Meek, A. 1916.1 (*p.* 310).

Natural history. Köhler, W. 1907.1.

Family Anabantidæ

For maps showing the distribution of the Anabantidæ, see Boulenger, G. A. 1904.7 (*p.* 645), *and* Meek, A. 1916.1 (*p.* 311).

Taxonomy. — Indian Archip. Bleeker, P. 1879.3. — *Asiatic species.* Regan, C. T. 1909.2. — *General paper.* Canestrini, G. Add. 1860.1.

Anabas ("*Climbing Perch*"). *Natural history notes, popular articles, etc.* Boake, B. 1866.1; ★Daldorff, D. C. 1797.1; Dobson, G. E. 1879.1; Harting, P. 1861.1; La Blanchère, P. R. H. 1874.1; Lubach, D. 1864.3; Anon. 697.

For climbing habits and overland progression, see under Locomotion.

SUB-ORDER ANACANTHINI

Taxonomy. Synopsis. Gill, T. N. 1884.3; Regan, C. T. 1903.10. — *Indian species.* Day, F. 1865.2. — *Philippines.* Radcliffe, L. 1913.1. — *Fossil.* Woodward, A. S. 1889.2.

Family Macruridæ

Taxonomy. — Gulf of Genoa. Canestrini, G. 1863.1. — *Japan.* Jordan, D. S. & Gilbert, C. H. 1904.1.

Palæontology, otoliths of Austrian Tertiary. Schubert, R. J. 1905.1.

Krohnius filamentosus (*the larval form of Macrurus*), *descriptions.* Costa, A. 1869.1; Emery, C. 1879.1 (ii), 1879.2 (2); Facciolà, L. 1882.3.

Macrurus. *Natural history and occurrence.* Fulton, T. W. 1902.1. — *Off British coast.* Holt, E. W. & Byrne, L. W. 1904.1. — *In Norway.* Grieg, J. A. 1910.1. — *In Spain.* Perez Arcas, L. 1872.1,.2.

Taxonomy. — In Gulf of Genoa. Vinciguerra, D. 1879.1. — *Antarctic.* Dollo, L. 1900.3.

Family Gadidæ

General treatise. ★Damas, D. **1909.1.**

Geographical distribution. Dambeck, K. 1877.1, 1879.1; Redeke, H. C. 1909.1; ★Thompson, D. W. 1910.1, 1911.1,.3, 1912.3.

Natural history. Damas, D. 1909.3; Hoek, P. P. 1911.1; Petersen, C. G. 1902.3.

Spawning ground investigations. ★Schmidt, E. J. **1909.1.** — *Spawning conditions and places.* Anon. 327.

Taxonomy and occurrence. — In Gulf of Genoa. Canestrini, G. 1863.1. — *Systematic position.* Dietz, P. A. 1912.1. — *Synopsis, North America.* Gill, T. N. 1864.8,.21. — *Synopsis, general.* Kaup, J. J. 1858.3.

Gadus. — *Names.* Brevoort, J. C. 1873.4. — *Taxonomy. Synopsis of species.* Lütken, C. F. 1876.1 (v). — *Bib and Poor Cod distinguished.* McIntosh, W. C. 1886.6, 1888.1. — *Specific characters, with key to species found in northern waters.* ★Williamson, H. C. 1902.1, 1906.1, 1909.1.

Gadus æglefinus (*Haddock*). *Complete literature, reproduction, development, etc. Plate of larval forms.* ★Hoek, P. **1903.1.**

Natural history; North sea. Helland-Hansen, B. 1909.1. — *Comparison American and European specimens.* Welsh, W. W. 1915.1.

Haddock fisheries. Abbs, C. 1792.1; Goode, G. B. & Collins, J. W. 1882.1, 1887.5.

Gadus argenteus. *Natural history.* Fulton, T. W. 1901.1, 1902.1.

Gadus capellanus. *Mediterranean species, structure and taxonomy.* Fage, L. 1911.1.

Gadus esmarkii (*Norway Pout*). *Natural history.* Fulton, T. W. 1901.1; Garstang, W. 1900.4; Holt, E. W. Add. 1892.3.

Gadus merlangus (*Whiting*). *Complete literature of the whiting; reproduction, development, etc. Plate of larval forms.* ★Hoek, P. **1903.1.**

Natural history. Cornish, T. 1866.9, 1872.2; Masterman, A. T. 1901.1. — *In glacial clay of Gothland.* Munthe, H. W. 1910.1.

Gadus morrhua (callarius) (*Cod*). *Complete literature, reproduction, development, etc. Plate of larval forms.* ★Hoek, P. **1903.1.**

Natural history and occurrence of the cod. Atwood, N. E. 1859.1, 1865.2, 1866.2; Cobbold, T. S. 1858.1; Cormack, W. E. 1826.1; Day, F. 1879.4, 1880.6; Feddersen, A. F. 1880.2; Fraser, A. 1830.1, 1833.1; Haskell, E. H. 1883.1; ★Masterman, A. T. 1901.1; Reuter, O. O. 1904.1; Spinney, B. H. 1883.1; Wilcox, W. A. 1883.1; Bean, T. H. (*in Alaska*) Add. 1881.1; Koelreuter, J. G. Add. 1777.1.

Researches in North Sea and adjacent waters. Giard, A. & Cépède, C. (*spawning grounds*) 1907.1; Hartmann, R. 1880.1; ★Helland-Hansen, B. 1909.1. — *Danish waters.* Petersen, C. G. J. 1893.6, 1902.1, .4. — *Coast of Finland.* Sandman, J. A. 1905.3, 1906.1,.4.

Gadus pollachius (*Pollack*). *Natural history.* Dunn, M. 1887.1, Add. 1885.4; Pelagius, 1877.1; Walbaum, J. J. 1783.1.

Gadus pontassou. *Natural history.* Andrews, W. (*Irish waters*) 1864.1; Fulton, T. W. 1901.1.

Microgadus proximus *and* **tomcod.** *Natural history.* Hooper, E. J. (*in California*) 1875.1; Anon. 444.

Lota (*Burbot*). *General treatise.* Hofer, J. 1894.1.

Natural history, popular accounts, etc. Bean, T. H. 1878.1, 1884.2; Bernhard, C. 1904.1; Day, F. 1880.1; Frost, C. C. 1870.1; Gottberg, G. 1910.2,.4 (*in Finland*) Add. 1912.1; Poulet, J. B. 1879.1; Sander, H. 1788.1; Winkler, T. C. 1860.1; Wood, William 1870.1; Koelreuter, J. G. Add. 1774.1; Baker, H. Pre-Linn. 1748.1.

Occurrence in — Susquehanna R. Cope, E. D. 1879.4. — *Cattewater, England.* Hearder, W. 1904.1. — *Switzerland.* Lankester, E. R. 1912.1. — *Finland.* Sandman, J. A. 1896.3. — *Lake Winnipisseogee, N. H.* Storer, D. H. 1844.5,.11. — *Pacific slope waters of North America.* Eigenmann, C. H. Add. 1894.1.

For a map showing the geographical distribution of the fresh-water Lota, see Meek, A. 1916.1 (*p.* 236).

Merluccius (*Hake*). —*Occurrence in fresh-water in Denmark.* Feddersen, A. F. 1880.2. — *Fisheries in the United States.* Goode, G. B. & Collins, J. W. 1887.6.

Molva (*Ling*). *Ling fisheries in Ireland.* Andrews, W. Add. 1861.1.

Occurrence of M. abyssorum — in Iceland and the Faroe Islands. Holt, E. W. L. 1893.2. — *in British waters.* Sim, G. 1897.1.

For a map showing the geographical distribution of the species of the genus Molva, see Meek, A. 1916.1 (*p.* 236).

Motella (Onus) (*Rockling*). *Natural history.* Holt, E. W. 1897.3; Le Danois, E. 1913.5; Dunn, M. Add. 1889.1.

Taxonomy. — *Key to species.* Collett, R. 1892.1. — *Synopsis.* Lütken, C. F. 1876.1 (v).

Raniceps (*Tadpole-fish*). *Taxonomy based on skull structure.* Gill, T. N. 1891.5.

SUB-ORDER ACANTHOPTERYGII

Taxonomy. — *Indian species.* Day, F. 1865.2, 1868.1, 1876.1. — *Synopsis of families.* Günther, A. C. 1862.6. — *Zanzibar.* Playfair, R. L. 1866.1. — *Revision, African species.* Boulenger, G. A. Add. 1909.1. — *Structure and taxonomy, fossil forms.* Woodward, A. S. 1889.2. — *Loricati, taxonomy.* Gill, T. N. 1888.4, 1889.5. — *Percinæ, taxonomy.* Gill, T. N. 1862.29, 1863.1. — *Pharyngognathi.* Cartier, O. (*of Philippines*) 1874.1; Günther, A. C. (*of Zanzibar*) 1866.5. — *Squamipinnes.* Guichenot, A. 1879.1.

DIVISION PERCIFORMES

Natural history. — *General treatise.* Jardine, W. 1835.1, 1861.1.

Taxonomy. Canestrini, G. 1860.1; Fowler, H. W. 1906.8; ★Regan, C. T. 1913.2. — *East Indies.* Bleeker, P. 1849.5, 1862.1. — *Comparison of Percidæ with Scombridæ.* Bonaparte, L. C. 1842.1. — *Review, Cuban forms.* Poey y Aloy, F. 1871.1.

Family Berycidæ

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Aphredoderus (*Pirate Perch*). *For a map showing the distribution of Aphredoderus, see* Meek, A. 1916.1 (*p.* 285).

Holocentrum (*Squirrel-fish*). *Taxonomy — Revision, species from Indian Archip.* Bleeker, P. 1873.18. — *Holocentrum and allied forms.* Fowler, H. W. 1904.4. — *New species from Miocene of Malta.* Woodward, A. S. 1887.4.

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Family Pempheridæ

Taxonomy, Dutch East Indies. Bleeker, P. 1862.1, 1877.8.

Family Centrarchidæ

Fresh-water Basses and Sunfishes

For a map showing the distribution of the Centrarchidæ, see Meek, A. 1916.1 (*p.* 285).

General treatises. Engmann, P. 1909.3, 1911.2; ★Harris, W. C. & Bean, T. H. 1905.1.

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For a map showing the geographical distribution, see Meek, A. 1916.1 (*p.* 285).

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Family Lobotidæ

Taxonomy. Gill, T. N. 1882.7. — *Review, Japan.* Jordan, D. S. & Thompson, W. F. 1911.1.

Family Toxotidæ

Taxonomy, East Indian Archip. Bleeker, P. 1862.1, 1876.9.

For a map showing the geographical distribution of Toxotes, see Meek, A. 1916.1 (*p.* 285).

Family Nandidæ

For a map showing the geographical distribution of the Nandidæ, see Meek, A. 1916.1 (*p.* 287).

Taxonomy, Indian Archip. Bleeker, P. 1862.1, 1874.9.

Occurrence in Africa. Pellegrin, J. 1906.13.

Family Percidæ

Taxonomy, revision. Jordan, D. S. 1877.1.

Acerina. — *Natural history.* Ehrenbaum, E. 1896.1; Labonté, H. 1905.1. —*Length of habitation of Loire R.* Marchand, E. 1897.1. —*Fossil species, Russia.* Eichwald, C. E. 1873.1.

For a map showing the geographical distribution of Acerina, see Meek, A. 1916.1 (*p.* 290).

Ammocrypta (*Sand-darter*). *Natural history.* Jordan, D. S. & Copeland, H. E. 1877.2.

Aspro. *Natural history.* Hofer, J. 1908.1; Labonté, H. 1905.1, 1909.1.

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Taxonomy and nomenclature. Boulenger, G. A. 1892.4; ★Gill, T. N. 1877.1, 1895.7.

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Perca (*Perch*). *General treatises.* Henshall, J. A. 1903.1; Anon. 446.

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For a map showing the geographical distribution of the genus Perca, see Meek, A. 1916.1 (*p.* 288).

Sub-family Etheostominæ

Natural history, popular accounts of the Darters. Jordan, D. S. & Copeland, H. E. 1876.2; Putnam, F. W. 1872.4.

Taxonomy. —*Southern Appalachians.* Cope, E. D. 1871.10. — *Revision.* Jordan, D. S. 1877.1. —*General review.* ★Vaillant, L. L. **1873.1**, 1873.6.

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Family Serranidæ

Popular general treatise. ★Harris, W. C. & Bean, T. H. 1905.1.

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Sub-family Serraninæ

Taxonomy. — *Review, Indian Archip.* Bleeker, P. 1874.7. — *Review, American forms.* Jordan, D. S. & Swain, J. 1885.4. —*General account.* Vaillant, L. L. 1873.4.

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Taxonomy, genus Labrax of Cuvier. Gill, T. N. 1861.4, Add. 1889.3.

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Taxonomy. Gill, T. N. 1861.4.
Fisheries, North Carolina. Worth, S. G. 1889.1.

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Stereolepis (*Jew-fish*). *Taxonomy.* Boulenger, G. A. (*Variations*) 1907.14; Gill, T. N. 1864.6.

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Sub-family Grammistinæ

Taxonomy, East Indies. Bleeker, P. 1862.1.

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Sub-family Priacanthinæ

Taxonomy. Bleeker, P. 1862.1, 1873.22. — *Review, Japan.* Jordan, D. S. & Thompson, W. F. 1912.1.

Sub-family Centropominæ

Taxonomy. Gill, T. N. 1882.6.

Sub-family Pomatominæ

Taxonomy. Gill, T. N. 1882.4.

Pomatomus (*Bluefish*). — *Natural history.* Atwood, N. E. 1869.2, 1871.2; Ayres, W. O. 1852.1; ★Baird, S. F. 1873.26; Bean, T. H. 1891.2; Macy, Z. 1893.1. — *Nomenclature.* Gill, T. N. 1883.10.

Sub-family Ambassinæ

Ambassis *and* **Parambassis,** *revision, Indian Archip.* Bleeker, P. 1874.5.

Sub-family Chilodipterinæ (Apogoninæ)

Taxonomy. — *Indian Archip.* Bleeker, P. 1874.6. — *Review, Japan.* Jordan, D. S. & Snyder, J. O. 1901.8. — *Philippine Is.* Radcliffe, L. 1911.1, 1912.1.

Sub-family Lutjaninæ

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Sub-family Cirrhitinæ

Taxonomy. Boulenger, G. A. 1896.6; Regan, C. T. 1911.11. — *Revision, Indian Archip.* Bleeker, P. 1875.7. — *Synopsis.* Gill, T. N. 1863.23. — *Review, Japan.* Jordan, D. S. & Herre, A. C. 1907.1.

Sub-family Pentacerotinæ

Histiopterus *and related genera. Taxonomy, review, Japan.* Jordan, D. S. 1907.5.

Family Anomalopidæ

(Doubtfully placed here)

Taxonomy. Weber, M. 1913.1 (*pp.* 189–191).

Family Pseudochromididæ

Taxonomy — *Revision, Indian Archip.* Bleeker, P. 1874.10, 1875.6. — *Review, Japan.* Jordan, D. S. & Snyder, J. O. 1902.7.

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Natural history, discovery, disappearance, rediscovery, etc. Bumpus, H. C. 1898.5, 1899.3; ★Collins, J. W. 1884.1; Goode, G. B. & Bean, T. H. (*First description*) 1879.5; Lucas, F. A. 1905.1, Add. 1889.1; Sandman, J. A. 1898.2; Günther, A. C. Add. 1897.1.

Family Cepolidæ

Taxonomy, review, Japan. Jordan, D. S. & Fowler, H. W. 1903.2.

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Family Hoplognathidæ (Oplegnathidæ)

Taxonomy, review, Japan. Jordan, D. S. & Fowler, H. W. 1902.6.

Family Sillaginidæ

Taxonomy. — *Indian Archip.* Bleeker, P. 1874.3. — *Synopsis.* Gill, T. N. 1862.27. — *Review, Japan.* Jordan, D. S. & Snyder, J. O. 1902.7.

Family Sciænidæ

For "singing" by Sciænoid fishes, see under Sound Production.
Taxonomy. — *Indian Archip.* Bleeker, P. 1850.5, 1851.9, 1874.3. — *Revision of North American forms.* Gill, T. N. 1862.20, 1863.7, 1864.2. — *Review, America and Europe.* ★Jordan, D. S. & Eigenmann, C. H. 1889.1. — *Review, Japan.* Jordan, D. S. & Thompson, W. F. 1911.2. — *Fossil remains.* Lörenthey, I. 1911.1. — *Brazil.* Steindachner, F. 1863.2.

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Family Gerridæ

Taxonomy, review, Japan. Jordan, D. S. 1907.4.

Gerres. *Taxonomy, revision, American species.* Evermann, B. W. & Meek, S. E. 1883.1, 1886.1.

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Family Trichodontidæ

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Family Pristipomatidæ (Hæmulidæ)

Taxonomy, review, Japan. Jordan, D. S. & Thompson, W. F. 1912.1.

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Family Sparidæ

Taxonomy. — *Sunda-Molucca Archip.* Bleeker, P. 1850.6, 1851.9. — *Review, America and Europe.* ★Jordan, D. S. & Fesler, B. 1893.1. — *Review, Japan.* ★Jordan, D. S. & Thompson, W. F. 1912.1. — *Monograph, Cuba.* Poey y Aloy, F. 1874.1. — *Limits of family.* Troschel, F. H. 1849.1.

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Cæsio. *Taxonomy, revision, Indian Archip.* Bleeker, P. 1873.17.

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Chrysophrys *and* **Sargus.** — *Taxonomy, revision.* Bleeker, P. 1877.12. — *Fossil teeth.* Costa, O. G. 1863.1.

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Mæna *and allied forms. Taxonomy, Indian Archip.* Bleeker, P. 1850.3, 1851.9.

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Family Mullidæ

Taxonomy. — *Revision, Indian Archip.* Bleeker, P. 1875.5. — *American species.* Hall, E. A. & McCaughan, J. Z. 1886.1. — *Japan.* Snyder, J. O. 1907.1.

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Family Caproidæ (Antigoniidæ)

Relationships. Starks, E. C. 1902.1.

Family Chaetodontidæ

Taxonomy. — *East Indies.* ★Bleeker, P. 1850.1, 1862.1, 1877.4, **1877.9**. — *Review, North American species.* Eigenmann, C. H. & Horning, J. E. 1887.1. — *Review, Japan.* ★Jordan, D. S. & Fowler, H. W. 1902.2. — *General paper.* Kaup, J. J. 1860.5.

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Family Teuthididæ (Siganidæ)

Taxonomy. — *Sunda-Molucca Archip.* Bleeker, P. 1850.7. — *Synopsis of genera.* Gill, T. N. 1885.5. — *Relationships.* Starks, E. C. 1907.1.

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Family Osphromenidæ

For a map showing the geographical distribution of the Osphromenidæ, see Meek, A. 1916.1 (*p.* 312).

Taxonomy. Bleeker, P. (*Indian Archip.*) 1879.3; Brüning, C. 1905.3.

Betta (*Fighting-fish*). *Natural history accounts.* Bause, B. 1897.1; Träber-Klotsche, G. 1912.4; Hipler, J. Add. 1914.1.

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Osphromenus (*Gourami*). — *Natural history.* Artaud, J. B. L. 1821.1, 1829.1; Cavenne, - 1827.1; ★Dabry de Thiersant, P. 1870.1; Feddersen, A. F. 1878.3; ★Gill, T. N. 1874.3; Hardwicke, T. 1829.1; Melnikov, V. S. 1902.2; Pearson, J. 1911.1; Sauvage, H. E. 1874.3. — *Distribution.* Senoner, A. 1870.1.

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Family Embiotocidæ

Surf Fishes

General treatise. ★Eigenmann, C. H. 1894.4.

Taxonomy. Californian forms. (*Original definition.*) Agassiz, J. L. 1853.4, 1854.1, 1861.1; Eigenmann, C. H. & Ubrey, A. B. 1894.1; Gibbons, W. P. 1854.1; Girard, C. F. 1856.7,.9, 1890.2. — *Review, Japanese species.* Jordan, D. S. & Sindo, M. 1902.1.

Family Cichlidæ (Chromidæ)

For maps showing the distribution of the Cichlidæ, see Boulenger, G. A. 1904.7 (*p.* 672), *and* Meek, A. 1916.1 (*p.* 313).

General treatises. — *Popular.* Engmann, P. 1911.1, 1912.1. — *Scientific monograph.* ★Pellegrin, J. **1904.2.**

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Crenicichla, Crenacara *and* **Batrachops.** *Taxonomy.* — *Revision.* Regan, C. T. 1905.16. — *Synopsis, Crenicichla.* Regan, C. T. 1913.21.

Geophagus, Biotœcus, Heterogramma *and* **Retroclus.** — *Taxonomy.* Engmann, P. 1903.1. — *Revision.* Regan, C. T. 1906.12.

Heros. *Natural history.* Melnikov, V. S. 1902.1.

Ptychochromis. *Taxonomy, synopsis.* Pellegrin, J. 1907.15.

Family Pomacentridæ

Taxonomy. — *Indian Archip.* ★Bleeker, P. **1877.3.** — *Synopsis, North America, west coast.* Gill, T. N. 1864.22. — *Review, Japan.* Jordan, D. S. & Snyder, J. O. 1902.5.

Family Labridæ

Wrasses

Taxonomy. — *Indo-Australian Archip.* ★Bleeker, P. 1847.1, 1849.8, 1862.1,.2,.10. — *Mediterranean.* Canestrini, G. 1868.1. — *North America.* Gill, T. N. 1864.15. — *France.* ★Gouret, P. 1893.1. — *Synopsis of genera.* Günther, A. C. 1861.12. — *Brazil.* Heckel, J. J. 1840.1. — *Hawaiian Is.* Jenkins, O. P. 1901.2. — *Review, America and Europe.* ★Jordan, D. S. **1891.6.** — *Review, Japan.* Jordan, D. S. & Snyder, J. O. 1902.5. — *General account.* Kner, R. 1860.5. — *Europe.* Degland, C. D. Add. 1839.1.

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Labrichthys *and* **Pseudolabrus.** *Structure and taxonomy.* Gill, T. N. Add. 1891.2.

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Family Scaridæ

Parrot Wrasses

Taxonomy, Indian Archip. Bleeker, P. 1861.4, 1862.1. — *Catalogue, specimens in Paris Museum.* Guichenot, A. 1865.1. — *Hawaiian Is.* Jenkins, O. P. 1901.2. — *Review, Japan.* Jordan, D. S. & Snyder, J. O. 1902.5. — *West Indian forms.* Jordan, D. S. & Swain, J. 1885.2.

DIVISION SCOMBRIFORMES

Taxonomy. Bleeker, P. (*Sunda-Molucca Archip.*) 1851.9; Fowler, H. W. 1904.5; ★Regan, C. T. 1909.13.

Family Carangidæ

Taxonomy. — *General synopsis.* Gill, T. N. 1883.9. — *Synopsis, North America.* Gill, T. N. 1863.22. — *Review, American forms.* Jordan, D. S. & Gilbert, C. H. 1884.6. — *United States.* Goode, G. B. 1882.1. — *Catalogue, Paris Museum.* Guichenot, A. 1865.2. — *Queensland.* Ogilby, J. D. 1915.1. — *Relationships.* Starks, E. C. 1911.5.

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Family Rhachicentridæ (Elacatidæ)

Taxonomy. Gill, T. N. 1888.1.

Rhachicentron (**Elacate**) (*Cobia or Crab-eater*). — *Natural history, young.* Bean, T. H. 1888.5; Fisher, A. K. 1891.1; Osburn, R. C. 1911.12. — *Nomenclature.* Gill, T. N. 1896.5.

Family Scombridæ

Taxonomy. Gill, T. N. 1863.8,.17. — *Italy.* Damiani, G. 1909.1. — *Review, America and Europe.* Dresslar, F. B. & Fesler, T. 1889.1. — *Japan.* Kishinouye, K. 1893.1; Kitahara, T. 1897.1. — *Scotland.* Walker, R. 1874.2. — *Relationships.* Starks, E. C. 1909.1, 1910.1.

Cybium (**Scomberomorus**) (*Spanish Mackerel*). — *Fossil forms, Tertiary of Belgium.* Demenge, E. 1897.1; Storms, R. 1892.1, 1895.1. — *Natural history.* Earll, R. E. 1883.2. — *Taxonomy, revision, American species.* Meek, S. E. & Newland, R. G. 1885.1. Poey y Aloy, F. 1879.1.

Gymnosarda (*Little Tunny*). *Fisheries, in Japan.* Okamura, K. & Marukawa, H. 1909.1.

Scomber (*Mackerel*). *Complete literature, reproduction, development, etc. Plate of larval forms.* ★Hoek, P. **1903.1.**

Natural history. Badham, C. D. 1853.1; Bullen, G. E. 1913.1; Cligny, A. 1906.2; Couch, J. 1844.2; Couch, R. Q. 1844.1, 1851.3; Dunn, M. 1893.1; ★Ehrenbaum, E. 1905.3, Add. **1914.2**; Goode, G. B. 1884.5; Gunner, J. E. 1770.1; Herdman, W. A. 1913.2; Lönnberg, A. J. 1907.7; Moore, P. 1899.1; Marion, A. F. 1894.6, Add. 1889.3; Nilsson, D. 1914.1; Sandman, J. A. 1899.2; Anon. 646; Holt, E. W. Add. 1892.6; Deslandes, A. F. Pre-Linn. 1724.1; Gronovius, J. F. Pre-Linn. 1744.1. — *Variations, races, and migrations.* ★Garstang, W. 1897.3, 1898.1, Add. 1897.1.

For a map showing the geographical distribution of Scomber scombrus, see Meek, A. 1916.1 (*p.* 319).

Thynnus (**Orcynus**) (*Tunny or Tuna*). *Biology and fisheries in the Mediterranean.* ★Sanzo, L. 1910.2; Amico, F. C. Add. 1816.1; Roule, L. Add. 1914.1.

Natural history notes, descriptions and occurrences. Collett, R. 1879.1; Day, F. 1886.2; Collett, R. 1882.1; Jackson, J. B. 1844.1; Lönnberg, A. J. 1907.7; McIntosh, W. C. 1886.1; Schulze, F. E. 1903.1; Walker, R. 1874.2; Anon. 716; Cunningham, J. T. Add. 1895.3.

Nomenclature. Gill, T. N. 1894.3, Add. 1888.4; Jordan, D. S. 1889.5.

Fossil forms from — Oligocene of Rumania. Simionescu, J. T. 1906.2. — *Pliocene of Belgium.* Storms, R. 1889.1. — *Tertiary of Suffolk.* Woodward, A. S. 1890.1.

Family Trichiuridæ (Lepturidæ)

Taxonomy. Gill, T. N. (*Synopsis*) 1864.19; Regan, C. T. 1909.13.

Lepidopus (*Frostfish*). *Natural history and occurrence — in New Zealand.* Arthur, W. 1884.2. — *in Dublin Bay.* Ball, Robert. 1855.1. — *in Finmarken, Norway.* Collett, R. 1913.1. — *in market of Naples.* Costa, A. 1868.1. — *in Gulf of Quarnero, Italy.* Ninni, A. P. 1862.1. — *in Norway.* Grieg, J. A. 1913.1.

Taxonomy, first description. Goüan, A. 1770.1.

Ruvettus (*Escolar*). *Mode of capture at Funafuti.* David, (Mrs.) T. W. Add. 1899.1; Hedley, C. Add. 1897.1.

For the purgative effects of the oil of this fish, see under Economic Products, *under* Fisheries.

Trichiurus (*Cutlassfish, Scabbardfish, Hair-tail*). *Occurrence. — on English coast.* Clogg, S. 1871.1; Cornish, T. 1867.4, 1871.2, 1872.5; Gatcombe, J. 1871.1. — *on coast of Scotland.* Edwards, T. 1876.1; Hoy, J. 1815.1. — *in Portugal.* Holten, H. S. 1802.2. — *in French waters.* Vaillant, L. L. 1897.6.

Family Histiophoridæ
Sailfishes

General treatise. Goode, G. B. 1883.7.

Taxonomy. Kampen, P. N. (*Java*) 1908.1; Regan, C. T. 1909.13.

Histiophorus. *Natural history, popular accounts, etc.* Barnes, W. M. 1883.1; Broussonet, P. M. A. 1786.2; Diaz y Martinez, E. 1910.2; Hector, J. 1869.1; Osburn, R. C. 1910.7; Ramsay, E. P. 1881.4; Rea, P. M. 1909.1; Anon. 492.

Taxonomy. ★Lütken, C. F. 1874.1 (iv), 1876.2, 1877.3. — *H. herschelli compared with Xiphias gladius.* Hector, J. Add. 1898.1.

Fossil forms, structure and taxonomy. Marsh, O. C. 1870.1. — *In Pliocene of Siena Prov., Italy.* ★Barbolani di Montauto, G. Add. 1910.1.

Tetrapturus. *Taxonomy and occurrence.* Canestrini, G. 1861.6. — *Madeira Is.* Lowe, R. T. 1840.1. — *In Adriatic.* Trois, E. F. 1880.1.

Family Palæorhynchidæ
Eocene, Miocene and Pliocene

Classification. Regan, C. T. 1909.13.

Hemirhynchus. *Occurrence, structure and taxonomy. — At Puteaux, France.* Gervais, F. L. P. 1872.2; Meunier, S. 1872.1. — *Taxomony.* Kner, R. 1867.2.

Palæorhynchus. *Occurrence. — at Puteaux, France.* Gervais, F. L. P. 1872.2; Meunier, S. 1872.1. — *in Eocene of Italy.* Pasquale, M. 1904.1.

Family Xiphiidæ

General treatise. Goode, G. B. 1883.7.

Nomenclature. Gill, T. N. 1883.4.

Taxonomy and distribution. Goode, G. B. 1882.5; Regan, C. T. 1909.13.

Xiphias (*Swordfish*). *Natural history notes, miscellaneous accounts, descriptions, occurrences.* Bureau, L. 1895.1; Cheeseman, T. F. 1876.1; Friedel, E. 1880.3; Holder, C. F. 1876.1; Koelpin, A. B. 1770.1, Add. 1775.1; Knox, F. J. 1870.1; Lanman, C. 1881.1; Münter, J. A. 1876.1; Schnee, S. 1903.3; Sprenger, W. 1900.8.

Swordfish fisheries. Osburn, R. C. 1912.7; Anon. 311. — *United States.* Clark, A. H. 1886.1; Goode, G. B. 1887.2; — *Italy.* Mazzullo, L. 1906.1; ★Mercadante, L., Jannaci, F. & Adorno, M. 1906.1; Brydone, P. Add. 1806.1; Ray, J. Pre-Linn. 1673.1; Silos, G. Pre-Linn. 1683.1.

Pre-Linnæan refs. to the Swordfish. Hannæus, G. 1690.1; Hanow, M. 1737.1; Larren, J. 1707.1; Warren, G. 1667.1.

For swordfishes attacking vessels, and fighting whales, see under Predatory fishes.

Family Luvaridæ

Classification. Regan, C. T. 1909.13.

Luvarus (**Ausonia**). *Natural history and occurrence.* Collenette, A. 1904.1; Holder, C. F. 1901.1. — *At Falmouth.* Bullmore, W. K. 1863.1, 1866.1. — *On Irish coast.* Constable, W. J. 1911.1. — *On coast of Cornwall.* Cornish, T. 1866.1. — *At Malta.* Gulia, Giovanni. 1910.1. — *At Venice.* Ninni, E. 1900.1. — *On south coast of Ireland.* Scharff, R. F. 1901.1. — *In Adriatic Sea.* Trois, E. F. 1867.2, 1909.1. — *On coast of Finistère, France.* Vaillant, L. L. 1895.4; Delage, Y. Add. 1914.1.

Family Coryphænidæ

Taxonomy. Cocco, A. 1886.1.

Coryphæna (*Dolphin*). *Early description.* Ankarkrona, T. Pre-Linn. 1740.1.

Family Bramidæ

Brama (*Pomfret*). — *Natural history.* Collin, J. 1874.1; Künstler, J. & Chaine, J. 1906.3. — *Taxonomy, revision.* Lunel, G. 1865.1.

Pterycombus. *Natural history.* Lilljeborg, W. 1864.1; Shufeldt, R. W. 1912.2.

DIVISION ZEORHOMBI

Family Zeidæ

Taxonomy and relationships. Cligny, A. 1912.7; Starks, E. C. 1898.2.

Zeus (*John Dory*). *Natural history notes.* Kner, R. 1865.5; Rasch, H. H. 1871.1; Lennier, G. Add. 1895.1.

Oreosoma (*A genus founded on young of a fish allied to Cyttus*). *Taxonomy and relationships.* Boulenger, G. A. 1903.16; Vaillant, L. L. 1893.2.

Family Amphistidæ

For Amphistium paradoxum from the Upper Eocene, see Woodward, A. S. 1889.2 (*vol. 4, pp.* 434, 435).

FAMILY PLEURONECTIDÆ

Used in the inclusive sense, equivalent to the suborder Heterosomata, including the Pleuronectidæ and Soleidæ, and the numerous other forms recently elevated to family rank. This arrangement is adopted by us as a matter of convenience in citation rather than as any expression of taxonomic relationships.

As articles on the Pleuronectidæ are, in nearly every case, inclusive in their treatment, the citations under the various sub-divisions below will be found to overlap each other greatly as to actual subject matter.

Summary of literature on Dab, Sole, and Turbot. ★Hoek, P. **1903.1.**

Summaries of literature on the Plaice. Duncker, G. 1895.1,.2, 1896.1; Herdman, W., Scott, A., Johnstone, J. & Cole, F. 1902.1; ★Hoek, P. **1903.1**.

Detailed descriptions of the various species. Fries, B., Eckstrom, C. & Sundevall, C. 1836.1, (*English trans.*) 1893.1; Krøyer, H. N. 1838.1; Day, F. 1880.2; Günther, A. 1859.1.

Briefer diagnoses of the species. Möbius, K. & Heincke, F. 1883.1.

NATURAL HISTORY

Chiefly comprehensive accounts, including in some cases short references to subjects treated in detail in the sections below. Baldwin, A. H. 1863.1, 1879.1; Cunningham, J. T. 1894.1; Fulton, T. W. 1905.3; Lönnberg, A. J. 1894.6; ★Redeke, H. C. 1909.2; Anon. 449; Cockerell, T. D. Add. 1890.1.

Arnoglossus laterna *and* **thori.** Holt, E. W. Add. 1892.1, 1897.2.

Hippoglossus vulgaris (*Halibut*). Goode, G. B. 1885.2; ★Thompson, W. F. 1915.1; Ehrenbaum, E. Add. 1914.4; Holt, E. W. Add. 1892.4.

Pleuronectes (Glyptocephalus) cynoglossus (*Witch*). *On coast of North America.* Goode, G. B. & Bean, T. H. 1878.1.

Pleuronectes flesus (*Flounder*). Ascroft, R. L. 1900.2; Braun, M. G. 1880.1; Collin, J. 1876.1; Ehrenbaum, E. 1911.6; ★Herdman, W. A., Scott, A. & Johnstone, J. 1890.1; Sandman, J. A. 1906.1,.4.

Pleuronectes limanda (*Dab*). Petersen, C. G. 1893.3.

Pleuronectes (Glyptocephalus) microcephalus (*Lemon Dab*). Holt, E. W. Add. 1893.4.

Pleuronectes platessa (*Plaice*). Apstein, C. 1894.1–1905.1; Brüssow, — 1879.1; ★Cole, F. J. & Johnstone, J. 1901.1; Cunningham, J. T. 1895.2,.3; Faber, F. 1828.2; ★Garstang, W. 1905.4, .6, 1909.1; ★Johansen, A. C. 1905.1, 1909.1, 1910.1, 1912.1; Malard-Duméril, — 1898.1; ★Gilson, G. Add. 1910.1; Hannemann, B. J. Pre-Linn. 1698.1. — *Putnam's flat fish, a smooth Plaice.* Bean, T. H. 1879.12. — *Vitality of trawl-caught plaice.* Borley, J. O. 1909.2.

Rhombus maximus (*Turbot*). Day, F. 1880.9; Goode, G. B. 1880.19; Levander, K. M. 1897.3; Sandman, J. A. 1906.4; Holt, E. W. Add. 1892.5.

Solea vulgaris (*Sole*). ★Cunningham, J. T. **1890.2**; Houghton, W. 1883.1; ★Redeke, H. C. & Tesch, J. J. 1911.1; ★Ehrenbaum, E. Add. 1914.5; Green, W. S. Add. 1890.1. — *Eggs of sole attached to shrimp.* Deslandes, A. F. Pre-Linn. 1724.1, 1753.1; Needham, J. T. Pre-Linn. 1745.1.

AMBICOLORATION

Being the partial or complete development of pigmentation on the eyeless and ordinarily colorless side.

For adjustment in coloration to the surroundings and effects upon coloration of extirpation of the eyes, see under Coloration.

General accounts and summaries of various theories as to cause. Bateson, W. 1894.2, 1895.1; ★Gemmill, J. F. **1912.1**; ★Hussakof, L. **1914.3.**

Records of Occurrence of Ambicolorate Specimens

Chiefly the flounder, plaice, sole, and turbot, and including partially ambicolored or "piebald" specimens. Bos, J. R. 1886.1; Elmhirst, R. 1911.1; Filhol, H. 1889.1; Johnstone, J. 1909.1; Nicols, A. 1873.1; Pouchet, G. 1892.1; Ritchie, J. 1908.1; Rodd, E. H. 1862.1; Sacchi, M. 1898.1; Schleep, B. C. 1829.1; Toni, E. 1888.1; Trois, E. F. 1908.1, 1909.2. — *No change in coloration after extirpation of eyes.* Buijtendijk, F. J. J. 1911.1. — *Platessa oblonga with both sides equally colored.* Storer, D. H. 1844.10, 1855.1.

Cases of inversion of coloration, i. e., absence of pigmentation on ocular side and appearance of color below. Noury, E. 1909.1; Sacchi, M. 1899.1,.2. — *Engyophrys, normally pigmented on blind side.* Jordan, D. S. & Bollman, C. H. 1890.1.

Theories of causation

Ambicoloration caused by abnormal movements in swimming. Giard, A. 1892.3. — *This view contradicted by aquarium experiments of* Cuénot, L. 1905.1, 1906.1; *and* Cunningham, J. T. 1895.1.

Ambicoloration in flatfishes a case of atavism. Kent, W. S. 1873.3. — *Contradiction of Kent's theory. Suggestion of crossing of normal and reversed specimens as cause of ambicoloration.* Romanes, G. J. 1873.1.

Experiments on action of light on the under side of flatfishes. ★Cunningham, J. T. 1891.3, 1893.1,.10; Cunningham, J. T. & MacMunn, C. A. 1893.1. — *Experiments on flatfishes living on slaty bottom.* Cunningham, J. T. 1895.1.

Theories deduced from the above and other experiments with light. — Ambicoloration due (at least in part) to the penetration of light through shallow water to the parts of the fish not in contact with the hard bottom. ★Cunningham, J. T. **1894.1**; Hussakof, L. 1914.3. — *Ambicoloration probably due to influence of sympathetic nervous system as well as action of light.* McIntosh, W. C. 1902.2,.3.

DEVELOPMENT

Including metamorphosis of the bilateral larvæ to the asymmetrical conditions of the adult. The subdivisions, "Asymmetry" and "Rotation of eye" are retained for convenience although these subjects are not readily separable.

Eggs and Larvæ

"The eggs of the Pleuronectidæ, like those of the Gadoids, are pelagic or floating, and the species begin life with a denatant drift in the current from deep to shallow water." Meek (A. 1916.1, *p.* 262).

This subject has been studied chiefly by means of the results of fishery investigations. For detailed reports and statistics, *see* the Reports *cited below under* Migrations. *See also under* Fisheries.

Descriptions of eggs of various Pleuronectidæ. Cunningham, J. T. 1888.1; Holt, E. W. 1891.5, 1893.4. — *Plaice eggs.* McIntosh, W. C. & Prince, E. E. 1890.1.

Eggs and larvæ in the North Sea. ★Ehrenbaum, E. 1897.1, 1908.2, 1910.1, .2, 1911.3; Bowman, A. (*Plaice*) Add. 1914.1.

Statistics of number of Plaice eggs — in Baltic. Hensen, V. & Apstein, C. 1897.1. — *in Loch Fyne.* Williamson, H. C. 1899.1.

Plate of larval forms. ★Hoek, P. 1903.1.

Spawning areas (chiefly North Sea and coasts of Ireland and Scotland). Meek, A. 1916.1.

General papers on the eggs and larvæ of Pleuronectidæ, including their distribution, quantity, development, etc. Kyle, H. M. 1900.7; McIntosh, W. C. 1892.2, 1894.2, 1895.1; ★Petersen, C. G. 1904.2, .4, 1906.2, 1909.2. — *Zeugopterus punctatus.* Cunningham, J. T. 1893.11. — *Rhomboidichthys mancus.* Facciolà, L. 1887.3. — *Pleuronectes cynoglossus.* Holt, E. W. & Byrne, L. W. 1903.2. — *Arnoglossus and Hippoglossus.* Williamson, H. C. 1911.2,.4.

Post-larval Stages

Chiefly metamorphosis. Papers treating in detail of this stage. ★Apstein, C. 1894.1, 1897.1, 1905.1; Kyle, H. M. 1898.1; McIntosh, W. C. 1888.3, 1889.2, 1896.4; Schmidt, E. J. 1904.2; Williamson, H. C. 1904.1.

Natural history and rate of growth of young plaice after metamorphosis is complete. Cunningham, J. T. 1896.1. — *Recent detailed account.* ★Fulton, T. W. **1902.3.**

Asymmetry of flatfishes

References to Asymmetry will also be found in many of the other articles cited in this section, particularly those *under* Ambicoloration, Rotation of Eye, *and* Post-larval stages.

First correct explanation of the asymmetry of the Pleuronectidæ. ★Traquair, R. H. 1865.1, **1865.2.**

Nature and development of the asymmetrical condition, structural changes, etc. Autenrieth, J. H. 1800.1; Beneden, P. J. 1853.3; Crichton-Browne, J. 1907.1; ★Cunningham, J. T. 1896.1; ★Duncker,

G. 1900.2; Fullarton, J. H. 1891.1; ★Fulton, T. W. **1902.3**; Malm, A. W. 1854.1, 1868.1, 1880.1; Marshall, W. A. 1885.1; Masterman, A. T. 1910.1, 1912.1; Pfeffer, G. J. 1886.1; Reichert, C. B. 1873.1; Sacchi, M. 1893.1, 1894.1; Steenstrup, J. J. 1863.1, 1864.3–1865.1, 1866.2; Steiner, J. 1886.1,.4; Thomson, C. W. 1865.1; Wright, E. P. 1878.1.

Structure of the optic chiasma in asymmetrical fishes. Mayhoff, H. 1912.1; ★Parker, G. H. **1903.2**; Williams, S. R. 1902.1.

Rotation of eyes

The change of the eyes of the larval flatfish during growth or metamorphosis from a bilateral condition to approximation on one side of the head, with the accompanying changes in the optic tract, cranial skeleton, etc.

As first enunciated by Traquair, the whole of the cranium in the region of the orbit has rotated on its longitudinal axis.

Various papers. ★Agassiz, A. 1876.1, 1877.2, 1878.1 (ii), 1879.3; Behr, A. 1899.1; ★Ehrenbaum, E. 1897.1 (i); ★Facciolà, L. 1885.2, 1887.3, 1901.1; Harting, P. 1866.2, 1878.5; Hawkes, A. J. 1907.1; ★Mayhoff, H. 1914.1; Nishikawa, T. 1897.1; ★Parker, G. H. **1903.2**; Pfeffer, G. J. 1894.2; Provazek, F. 1900.1; Schiodte, J. M. 1868.1, 1877.1; Thilo, O. 1902.3,.4, 1908.1; ★Williams, S. R. 1901.1, **1902.1**; Wright, E. P. 1879.1; Anon. 359; Hanow, M. Pre-Linn. 1737.1.

Views of Steenstrup who believed that one eye passed through the substance of the head. ★Steenstrup, J. J. 1866.2, 1876.1.

Records of cases of arrested rotation of the eyes, teratological conditions resulting in complete or partial retention of bilateral symmetry, often accompanied by other minor abnormalities in coloration, etc. Filhol, H. 1889.1; Giard, A. 1892.3; Holt, E. W. 1893.2; Johnstone, J. 1909.1; Ninni, E. 1906.1; Ritchie, J. 1908.1; Sacchi, M. 1898.1; Schleep, B. C. 1829.2; Storer, D. H. 1844.10.

Teratological specimens showing a reversal of the eye position, i. e., the occurrence of both eyes on the opposite side of that normal for the species. Specimens of — Turbot (Psetta maxima). Cunningham, J. T. 1907.1. —*Flounder.* Traquair, R. H. 1900.3.

DISTRIBUTION

Predominantly Northern

For distribution of eggs and larvæ, see also the articles cited above under Eggs and Larvæ.

For areal and bathymetric distribution, see particularly Cunningham, J. T. 1896.1; Day, F. 1880.2; Fulton, T. W. 1893.2; ★Hoek, P. **1903.1** (*Plaice, Sole, and Dab*); Holt, E. W. 1893.1; Johansen, A. C. 1905.1; ★Meek, A. **1916.1**.

Bathymetric distribution. Herdman, W. & Dawson, R. 1902.1; Schiemenz, P. 1902.1.

Distribution in Arctic waters. — *Alaska; Halibut.* Bean, T. H. 1879.10. — *Murman Coast and White Sea.* Knipovich, N. M. 1901.1, 1902.1. — *Behring Sea, Alaska and Sea of Okhotsk, and White Sea; Plaice.* Smitt, F. A. 1893.1.

Baltic Sea. Möbius, K. & Heincke, F. 1883.1. — *Plaice in Baltic.* Duncker, G. 1904.2; Krüger, Albert. 1903.1, 1904.1; Mortensen, O. T. J. 1895.1; Reibisch, J. 1904.1, 1907.1, 1911.1. — *Effect of low specific gravity on plaice distribution in Baltic.* Hensen, V. A. 1884.1; Petersen, C. G. 1894.1. — *Dab.* Schiemenz, P. 1902.1.

Distribution on coast of Finland. — *Plaice.* Fischer, J. 1875.1. — *Dab.* Malmgren, A. J. 1863.1. — *Halibut.* Sandman, J. A. 1906.1.

English coast. — *Hippoglossus vulgaris.* Holt, E. W. & Byrne, L. W. 1904.1; Kermode, P. M. 1897.1.

Germany. *Flounder.* — *in Upper Rhine.* Lauterborn, R. 1906.1. — *in Main R.* Thienemann, A. 1912.7.

Irish Sea and vicinity. Herdman, W. & Dawson, R. 1902.1; Holt, E. W. 1891.5. — *Firth of Clyde.* Scott, T. 1900.1.

Italian coast. — *Gulf of Genoa.* Canestrini, G. 1861.4. — *Adriatic Sea, Plaice.* Trois, E. T. 1878.3. — *Sea of Messina, Arnoglossus.* Facciolà, L. Add. 1886.1.

North America. Bumpus, H. C. 1898.6; Goode, G. B. & others. 1887.1. — *Turbot and Sole.* Goode, G. B. 1880.19.

North Sea and North Atlantic. — *North Sea.* Fulton, T. W. 1905.3, **1913.1**.

Plaice in North Sea. Bowman, A. Add. 1914.1; Garstang, W. 1909.2. — "*Proportionate distribution of the sexes of plaice in the North Sea.*" Hefford, A. E. 1909.1.

Icelandic waters. — *Dab.* Ehrenbaum, E. 1901.2. — *Plaice.* Faber, F. 1829.1.

East coast of Scotland. McIntosh, W. C. & Masterman, A. T. 1897.1. — *Firth of Forth.* Cunningham, J. T. 1896.1.

Netherlands. Redeke, H. C. 1904.1, 1905.3.

Scandinavian coast. — *Norway.* Collett, R. 1874.1, 1875.3. — *Snaasen Lake, Flounder.* Nordgaard, O. 1906.1.

Sweden. Solea vulgaris as a freshwater fish. Hintze, A. 1887.1.

Danish waters. Krøyer, H. N. 1838.1.

MIGRATIONS AND MARKING EXPERIMENTS

The majority of articles on these subjects have been published in 1902 and the following years in the Reports listed below: Rept. Lancashire Sea-Fisheries Lab., Liverpool; Rept. Fishery Board for Scotland, London; Mitt. Deutsch. Seefischereivereins, and the publications of the Commission Wissenschaft. Untersuch. Deutsch. Meere, Kiel.

Although the migratory movements of the various genera and species differ slightly owing to external influences, such as temperature, we may in the main use the following summary of

Cole & Johnstone (1901.1, *p.* 218) as applicable to the Pleuronectidæ in general.

> "Passive drift in-shore of developing eggs and metamorphosing larvæ terminating as the larva acquires the adult form and settles to the bottom. Slow outward movement of the young fish, deeper water being continually sought as it increases in size. This movement ends as the fish becomes mature. Thereafter its movements are probably very limited. During the spawning season it probably does not travel at all. With the extrusion of spawn another generation begins the migratory cycle."

The migratory habits of the flatfishes have been chiefly studied by means of marking experiments on plaice in the North and Irish and Baltic Seas. *For a bibliography on plaice marking experiments, see* Atkinson, G. T. 1912.1.

Marks in use in marking experiments. Heincke, F. & Bolau, H. 1906.1.

For investigations on the migration of Pleuronectidæ in order to determine questions of Size, Growth, Food, *and* Temperature effects, *see the larger papers cited in this section and also these subjects in the* Morphological Section.

General papers on the migrations of flatfishes. Cole, F. S. & Johnstone, J. 1901.1; ★Meek, A. **1916.1.** —*See also* J. T. Jenkins "The Sea Fisheries." London, 1920, 299 p. figs., *and various shorter papers on the results of the Northumberland investigations by* Meek, (A. 1905.1, 1909.2, 1913.1, 1914.2,.3, 1915.3).

For detailed reports on localities, seasons, etc. of mature spawning migrations of Pleuronectidæ, see particularly the Reports of the Dove Marine Laboratory, Cullercoats.

Seasonal migration of Pleuronectidæ (in-shore in summer and into deeper water in winter, until maturity is reached). —*Flounders marked in Elbe in autumn recaptured in Elbe.* Ehrenbaum, E. 1907.3. —*Young plaice appearing in the mouths of rivers.* Feddersen, A. 1879.1; Hoek, P. 1888.1; Seeley, H. G. 1886.1. —"*Where are plaice in winter?*" Petersen, C. G. J. 1893.2. —*Marked soles in the Zuyder Zee. Tendency to southwest migration.* Redeke, H. C. 1905.1, 1911.1. —*Flounders marked in Feb. and May on Bornholm grounds in Baltic, recaptured near coast the following summer.* Strodtman, S. 1906.1.

Effects of seasonal migrations analyzed —for Forth school. Thompson, D. W. 1914.2; Fulton, T. W. ("*Goldseeker*" *investigations*) 1913.2. —*for Northumberland school.* Meek, A. 1916.1, *p.* 271.

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Migratory habits peculiar to certain flatfishes. —*Plaice and Dab are usually found together. Plaice begins to spawn earlier in year than Dab.* Cunningham, J. T. Add. 1898.1. —*Flounder lives in estuaries and rivers, only descending to the sea in the spawning season.* Cunningham, J. T. Add. 1898.1.

Notes on migrations of Pleuronectidæ to various localities. (Chiefly seasonal feeding migrations.) —*From Kattegat to Baltic.* Mortensen, O. T. J. 1897.1. —*In Trondhjemsfjord, Norway.* Nordgaard, O. 1909.2. —*To coastal grounds on west coast of Jutland.* Johansen, A. C. Add. 1913.1,.2.

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PHYLOGENY

Evolution and origin of species of flatfishes. Bateson, W. 1894.1; ★Cunningham, J. T. 1892.1, 1895.6, Add. 1898.1; Giard, A. 1892.1; Regan, C. T. 1910.6; ★Thilo, O. 1899.2, 1903.3.

TAXONOMY

Family Pleuronectidæ

See also general papers on this subject under Taxonomy *in the* Morphological Section.

Systematic works. Andrews, W. 1849.5; Boulenger, G. A. 1901.15; ★Cunningham, J. T. 1893.1, **1895.6**, Add. 1894.1; ★Kyle, H. M. **1900.1**.

For group and generic names given to larval forms, see Jordan, D. S. & Goss, D. K. 1889.1.

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Variations and Relationships of various genera and species

Hippoglossoides, *Pacific species.* Schmidt, Peter. 1915.1.

Pleuronectes flesus. Duncker, G. 1900.2; Fabricius, O. 1824.1. —*Sweden.* Quensel, C. 1806.1. —*Relationships between P. flesus and P. platessa.* Duncker, G. 1895.1,.2, 1896.1; Hoek, P. P. 1890.2; Stead, F. B. 1897.4.

Pleuronectes platessa. Faber, F. 1840.1.

Variation of local forms. Cunningham,

J. T. 1895.5, (*in size*).10; ★Duncker, G. 1895.1,.2, 1896.1, 1913.1; Kyle, H. M. 1900.2; Petersen, C. G. 1894.1. —*Holland.* Gottsche, C. M. 1835.1. —*Baltic Sea.* Möbius, K. & Heincke, F. 1883.1. —*In Danish waters.* Stead, F. B. 1897.1. —*American " Plaice " a species of Paralichthys (P. dentatus).* Goode, G. B. & others. 1887.1.

Pleuronichthys. *Review.* Starks, E. & Thompson, W. 1910.1.

Zeugopterus. Petersen, C. G. 1904.2.

Sub-family Soleinæ (Plagusinæ)

Synopsis. Kaup, J. J. 1858.4,.5.

Solea. *Great Britain.* Holt, E. W. L. & Byrne, L. W. 1905.1.

Fossil forms. —*Solea in Miocene of Switzerland.* Musy, M. 1913.1. —*Solea in Eocene of Egypt.* Woodward, A. S. 1910.2.

DIVISION KURTIFORMES

Family Kurtidæ

Kurtus. *Systematic position.* Beaufort, L. F. Add. 1914.1.

DIVISION GOBIIFORMES

Taxonomy. Heckel, J. J. 1836.1; Regan, C. T. 1911.14; Steindachner, F. 1861.1. —*Sunda-Molucca Archip.* Bleeker, P. 1849.1, 1851.13, 1874.1, 1875.2. —*North America.* Gill, T. N. 1864.9,.18. —*Review, Japan.* ★Jordan, D. S. & Snyder, J. O. 1901.9. —*Species in Mus. Nat. Hist. Paris.* Sauvage, H. E. 1880.2.

Evolution; possible line of descent. Starks, E. C. 1911.6.

Family Gobiidæ

Taxonomy. —*East Indies.* Beaufort, L. F. 1912.1. —*Gulf of Genoa.* Canestrini, G. 1861.2. —*Norway.* Collett, R. 1875.1. —*American species.* Eigenmann, C. H. & R. S. 1888.2; Jordan, D. S. & Eigenmann, C. H. (*Review*) 1887.1. —*Great Britain.* Holt, E. W. L. & Byrne, L. W. 1903.1. —*Dalmatia.* Kolombatovič, J. 1891.1. —*Sweden.* Malm, A. W. 1874.2. —*Catalogue of Adriatic Sea forms.* Ninni, A. P. 1883.1. —*Taxonomy and natural history, Baltic sea.* Heincke, F. 1880.1.

Crystallogobius. —*Taxonomy and natural history, Norway.* Collett, R. 1877.2, 1878.3. —*Distribution, C. nilsonii.* Cunningham, J. T. 1891.1; Holt, E. W. Add. 1892.2.

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Taxonomy. —*Indian Archip. species.* Bleeker, P. 1878.1. —*Swedish species.* Fries, B. F. 1838.2. —*European forms.* Smitt, F. A. 1900.2; Fage, L. Add. 1914.1. —*Danish species.* ★Winther, G. P. 1874.3.

Latrunculus. —*Taxonomy. Review, East Indies.* Bleeker, P. 1876.8. —*Natural history and taxonomy.* Collett, R. 1873.1, 1877.2, 1878.3.

Lentipes. *Taxonomy; revision.* Grant, W. R. 1884.1.

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For terrestrial locomotion, see under Locomotion.

For use of caudal fin as an accessory respiration organ, see under Caudal respiration *under* Respiration.

Philypnus. *Taxonomy; monograph.* Gill, T. N. 1861.6, 1862.1.

Sicydium *and allies. Taxonomy — East Indies.* Bleeker, P. 1876.8. —*Revision.* Grant, W. R. 1884.1.

Sub-family Eleotridinæ

Taxonomy — Review. Indian Archip. Bleeker, P. 1877.10. —*Review, America.* Eigenmann, C. H. & Fordice, M. W. 1886.2. —*Australia.* Ogilby, J. D. 1897.2, 1898.6. —*Review, New South Wales.* Waite, E. R. 1904.6.

DIVISION DISCOCEPHALI

Classification. Regan, C. T. 1912.2.

Family Echeneididæ

For the use of the sucking fishes as " living fish hooks," see under Remora-fishing *in section on* Fishing Methods.

For the sucking disk of Echeneids as a transformed spinous dorsal fin, see under Adhesive Disk.

For Echeneids as ship-holders, see under Mythology and Symbolism.

Taxonomy and relationships. Bleeker, P. (*Sunda-Molucca Archip.*) 1852.3; Costa, O. G. 1844.1; Duméril, A. H. 1858.1; Gill, T. N. 1865.6, 1882.5; Lütken, C. F. 1874.1 (v), 1877.3.

Echeneis. *Natural history.* ★Günther, A. C. 1860.6; Harting, P. 1867.1. —*Alleged capture in Michigan.* Smith, H. M. 1903.2. —*Fossil form.* Wettstein, A. 1886.1.

Remora. *Earliest figures and references.* —*General accounts.* Eastman, C. R. 1915.3, Add. 1916.3. —*In Pre-Linnæan Section.* Aristotle (*First reference*) 1476.1; Braccio, I. 1634.1; Chevalier, J. D. 1752.1; Imperato, F. (*Earliest printed figure*) 1593.1; La Roque, 1682.1; Massey, W. 1753.1; Vallisnieri, A. 1725.1.

DIVISION SCLEROPAREI

Taxonomy, Indian Archip. Bleeker, P. 1849.6, 1851.9,.16.

Family Scorpænidæ

Taxonomy. —*E. Indian Archipelago.* Bleeker, P. 1876.3,.4. —*Review, Japan.* ★Jordan, D. S. & Starks, E. C. 1904.4. —*Mediterranean.* Roule, L. 1907.1. —*Species in Paris Museum.* Sauvage, H. E. 1878.1.

Histiocephalus. *Taxonomy; Eocene.* Molin, R. 1860.1.

Scorpæna (*Scorpionfish*). *Natural history.* Holder, C. F. 1900.1; Holt, E. W. Add. 1893.6.

Taxonomy. — *Mediterranean species.* Jaquet, M. 1907.1. — *Review, American species.* Meek, S. E. & Newland, R. G. 1886.1.

Sebastes (*Rosefish*). *Natural history.* Fulton, T. W. 1901.1; Holt, E. W. Add. 1892.7.

Taxonomy and distribution. — *California species.* Ayres, W. O. 1860.3, 1863.1. — *American species.* Gill, T. N. 1864.14, 1865.1. — *Review, Japan.* Hilgendorf, F. M. 1880.4. — *Greenland.* Kroyer, H. N. 1845.10. — *Taxonomy and geographical distribution.* Sauvage, H. E. 1874.1.

Revision of Sebastes and allied forms. Eigenmann, C. H. & Beeson, C. H. 1894.3.

Sebastodes (*Rockfish*). *Taxonomy and relationships.* Eigenmann, C. H. & Beeson, C. H. 1893.1. — *Mediterranean species.* Jaquet, M. 1907.1.

Synancia *and allied forms. Taxonomy.* — *East Indies.* Bleeker, P. 1874.8. — *General account.* Gill, T. N. 1905.8.

Family Hexagrammidæ

Taxonomy, review, Japan. Jordan, D. S. & Starks, E. C. 1903.3.

Family Comephoridæ

Taxonomy, Lake Baikal. Berg, L. S. 1906.8, 1907.2; Korotnev, A. 1905.1.

Anoplopoma (Scombrocottus). *Natural history.* Swan, J. G. 1885.1.

Comephorus. *Natural history.* Dybowski, B. I. 1873.1, 1901.1; Grube, A. E. 1875.1; Günther, A. C. 1871.6; Korotnev, A. 1904.1; Tur, J. 1903.1; Zograf, N. Y. 1901.2, 1902.2.

Cottocomephorus. *Taxonomy and affinities.* Berg, L. S. 1906.8, 1907.2; Pellegrin, J. 1906.14.

Family Cottidæ (*Sculpins*)

For geographical distribution of freshwater Cottidæ, see Meek, A. 1916.1 (*p.* 352).

Taxonomy. — *Lake Baikal.* Berg, L. S. 1903.1, 1906.8, 1907.2; Gracianov, V. I. 1901.1. — *Russia, fresh-water.* Gracianov, V. I. 1907.4. — *Fresh-water of North America.* Girard, C. F. 1852.2; Jordan, D. S. 1877.1. — *Review, Japan.* Jordan, D. S. & Starks, E. C. 1904.2. — *Greenland, Arctic forms.* Lütken, C. F. 1876.1 (i).

Cottus. *Natural history, distribution, etc.* Acloque, A. 1899.1; Bean, B. A. & Weed, A. C. 1910.2; ★Buschkiel, A. 1908.2; Lamarche, C. 1897.1; Lönnberg, A. J. 1900.7; Malmgren, A. J. 1870.1; Robinson, R. E. 1877.1. — *Distribution in Siberia.* Berg, L. S. 1906.5. — *Variation in Mälar Lake, Sweden.* Lönnberg, A. J. 1905.5.

Taxonomy, revision of genus. Girard, C. F. 1852.3; Jeitteles, L. H. 1861.1.

Fossil forms from — *Oligocene of Belgium.* Leriche, M. 1904.1. — *Tertiary of Aix.* Sauvage, H. E. 1873.7.

Myoxocephalus. *Natural history.* ★Gill, T. N. 1905.15.

Psychrolutes *and allies. Taxonomy, review.* Gill, T. N. Add. 1888.5.

Family Cyclopteriidæ

Taxonomy and relationships. Agassiz, J. L. 1858.7; ★Garman, S. 1892.1; Gill, T. N. 1891.6. — *Synopsis, eastern North America.* Gill, T. N. 1865.11. — *Review, Japan.* Jordan, D. S. & Snyder, J. O. 1902.4.

Cyclogaster *and related species. Taxonomy, Japan.* Gilbert, C. H. & Burke, C. V. 1912.2.

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For sucking disk, composed of the united ventral fins, see under Adhesive Disk.

Cyclopterichthys *and* **Liparops.** *Taxonomy.* Garman, S. 1892.1.

Family Liparididæ

Taxonomy. ★Garman, S. 1892.1. — *Review, Japan.* Jordan, D. S. & Snyder, J. O. 1902.4.

Liparis (*Sea Snail*). *Natural history.* Kroyer, H. N. 1861.2; Lütken, C. F. 1861.1,.2, 1862.1; McIntosh, W. C. 1885.2; Nozeman, C. Pre-Linn. 1757.2.

Occurrence. — *on French coast.* Cligny, A. 1912.5. — *in Swedish waters.* Ekström, C. 1832.1; Schagerström, N. O. 1838.2. — *on Massachusetts coast.* Putnam, F. W. 1874.2,.3,.10. — *in Finnish waters.* Reuter, O. M. 1892.1; Suomalainen, F. W. 1911.1. — *in Ireland.* Scharff, R. F. 1890.1. — *in Firth of Forth.* Evans, W. Add. 1897.1.

Family Platycephalidæ

Taxonomy. — *Revision, Indian Archip.* Bleeker, P. 1879.5. — *Japan.* Jordan, D. S. & Richardson, R. E. 1908.2. — *Species in Paris Museum.* Sauvage, H. E. 1878.1.

Family Hoplichthyidæ

Taxonomy, Japan. Jordan, D. S. & Richardson, R. E. 1908.2.

Family Agonidæ

Taxonomy, review, Japan. Jordan, D. S. & Starks, E. C. 1904.3.

Family Triglidæ

Taxonomy. Gill, T. N. 1888.4, 1889.5; Kaup, J. J. 1858.1, 1873.1; Sauvage, H. E. 1873.1. — *Synopsis, Maltese forms.* Gulia, Gavino. 1858.1. — *Japan.* Jordan, D. S. & Richardson, R. E. 1908.2. —

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Prionotus (*Sea Robin*). *Taxonomy, review.* Jordan, D. S. & Hughes, E. G. 1887.1.

Trigla (*Mailed Gurnard*). *Natural history.* Bianconi, G. G. 1856.1; Embleton, R. 1834.1; Emery, C. 1879.1 (x); Holder, C. F. 1909.1; Shufeldt, R. W. 1898.5; Holt, E. W. Add. 1898.5.

Family Dactylopteridæ

Taxonomy, synopsis. Gill, T. N. 1891.1.

Cephalacanthus (*larval form*). *Taxonomy, Japanese species and related forms.* Jordan, D. S. & Richardson, R. E. 1908.2.

Dactylopterus (*Flying Gurnard*). *Natural history (development).* Canestrini, G. 1861.3.

DIVISION JUGULARES

Taxonomy. Duméril, A. M. 1855.1.

Family Trachinidæ

Taxonomy. Boulenger, G. A. 1901.15.
Natural history. ★Gill, T. N. 1907.2.

Trachinus (*Weever*). *Natural history, popular accounts, descriptions, etc.* Emery, C. 1879.1 (xii); McIntosh, W. C. 1886.6; Meier, H. 1865.1; Winkler, T. C. 1857.5; Holt, E. W. Add. 1898.4.
Taxonomy. Review. Bleeker, P. 1861.7.
For poison glands and effects of poisons, see under Poisonous fishes.

Family Leptoscopidæ

Taxonomy. — *Synopsis of genera.* Gill, T. N. 1863.16. — *Review, Japan.* Jordan, D. S. & Snyder, J. O. 1902.7.

Chimarrichthys. *Taxonomy, synopsis.* Regan, C. T. 1905.17.

Family Nototheniidæ

Taxonomy. — *Synopsis.* Gill, T. N. 1862.25; Regan, C. T. 1914.1. — *Review, Japan.* Jordan, D. S. & Snyder, J. O. 1902.7. — *Tierra del Fuego.* ★Smitt, F. A. 1897.1.

Chænichthys. *Taxonomy, synopsis.* Gill, T. N. 1862.22.

Harpagifer. *Taxonomy, synopsis.* Gill, T. N. 1862.24.

Family Uranoscopidæ

Natural history. ★Gill, T. N. 1907.2.
Taxonomy. — *Synopsis.* Gill, T. N. 1862.9,.30. — *Review, Japan.* Jordan, D. S. & Snyder, J. O. 1902.7. — *Review of the European and American species.* Kirsch, P. H. Add. 1889.1.

Uranoscopus (*Star-gazer*). *Taxonomy. Review, Indian Archip.* Bleeker, P. 1878.4.

Family Callionymidæ

Taxonomy. — *Review, Indian Archip. species.* Bleeker, P. 1879.4. — *List of American species.* Eigenmann, C. H. & R. S. 1888.2. — *Review, Japan.* Jordan, D. S. & Fowler, H. W. 1902.4. — *Gulf of Genoa.* Canestrini, G. 1862.1.

Callionymus (*Dragonet*). *Taxonomy.* Fries, B. F. (*Synopsis*) 1839.1; Gill, T. N. 1860.10; Schagerström, N. O. (*Swedish species*) 1830.1.
Natural history notes, descriptions, etc. Doderlein, P. & Riggio, G. 1890.1; Ninni, A. P. 1877.1; Brook, G. Add. 1885.1; Holt, E. W. Add. 1898.1; Gronovius, J. Pre-Linn. 1740.1; Tyson, E. Pre-Linn. 1706.1.

Family Gobiesocidæ

Taxonomy. Brisout de Barneville, C. N. 1846.1. — *Review, Japan.* Jordan, D. S. & Fowler, H. W. 1902.3.

Lepadogaster (*Clingfish*). *Natural history accounts.* Brook, G. 1890.1; Byrne, L. W. 1902.2; Drew, J. 1872.1; Guitel, F. 1890.6.
Taxonomy. — *On French coast.* Jourdain, S. 1879.2. — *Synopsis.* Brisout de Barneville, C. N. 1846.3. — *Mediterranean Sea.* Canestrini, G. 1864.3. — *Differentiation of L. bimaculatus and L. microcephalus.* Guitel, F. 1904.1,.2.
For ventral sucking disk, composed of the united pelvic fins, see under Adhesive Disk.

Family Blenniidæ

Taxonomy. — *East Indies.* Bleeker, P. 1849.1, 1851.13. — *Gulf of Genoa.* Canestrini, G. 1862.1; Vinciguerra, D. 1879.1. — *Messina, Sicily.* Facciolà, L. 1885.1. — *Review, South African species.* Gilchrist, J. D. & Thompson, W. W. 1908.1, 1911.1. — *Review, Japan.* Jordan, D. S. & Snyder, J. O. 1902.3.

Blennius (*Blenny*). *Natural history notes.* Bonaparte, C. L. 1840.5; Forbes, E. 1836.1; Gervais, F. L. 1859.1; Lunel, G. 1870.1; Montagu, G. 1809.1; Mourgue, M. 1909.1; Steenstrup, J. 1865.2; Anon. 99; Walbaum, J. J. Add. 1775.1; Gissler, N. Pre-Linn. 1748.1.

Labrosomus. *Taxonomy, review.* Gill, T. N. 1861.5.

Lumpenus. *Natural history, occurrence, etc.* Brenner, M. M. 1874.1; Day, F. 1884.7, 1885.9; Fulton, T. W. 1901.1; Gottberg, G. 1910.3; Häyrén, E. 1900.1; Krøyer, H. N. 1837.2,.4,.5; ★Sim, G. 1887.1; Holt, E. W. Add. 1893.3.

Nemophis *and allies. Taxonomy and relationships.* Putnam, F. W. 1874.8.

Stichæus. *Taxonomy, synopsis.* Gill, T. N. 1865.5.

Family Batrachidæ

Natural history. ★Gill, T. N. 1907.2.
Taxonomy. — *Review, American species.* Meek, S. E. & Hall, E. A. 1886.1. — *Revision, Queensland.* Ogilby, J. D. 1908.4.

Opsanus (**Batrachus**) (*Toadfish*). *Batrachus gigas in Seychelles.* Ward, Swinburne. 1869.1.
For a study of the habits and life history of the Toadfish, with many illustrations and

with a review of the literature, see Gudger, E. W. 1910.1.

Thalassophryne *and* **Thallassothia.** *Revision.* Bean, B. A. & Weed, A. C. 1910.3.

Family Pholididæ

Nomenclature. Gill, T. N. 1896.17.

Pholis (*Gunnel or Butterfish*). —*Natural history notes.* Gottberg, G. 1910.5; Walbaum, J. J. Add. 1783.2. —*Nomenclature.* Gill, T. N. 1896.4.

Family Zoarcidæ

For a map showing the geographical distribution of the Zoarcidæ and related families, see Meek, A. 1916.1 (*p.* 380).

Taxonomy. —*Synopsis.* Gill, T. N. 1864.20. —*Review, Japan.* Jordan, D. S. & Fowler, H. W. 1902.5. —*Arctic Ocean.* ★Knipovich, N. M. 1906.3. —*Argentina.* Lahille, F. 1908.3.

Sub-family Anarrhichadinæ

Taxonomy. —*Gulf of Genoa.* Canestrini, G. 1862.1. —*Review, Japan.* Jordan, D. S. & Snyder, J. O. 1902.3.

Anarrhichas (*Wolf-fish*). —*Natural history notes, descriptions and occurrence.* Baird, S. F. 1876.4; Broussonet, P. M. 1785.2; Crisp, E. 1853.1; De Vis, C. W. 1865.1; Fulton, T. W. 1905.2; Gill, E. L. 1904.1, 1906.1; Jones, J. M. 1865.1; Young, M. & Eagle Clarke, W. 1892.1. —*Taxonomy and synonymy.* Steenstrup, J. J. 1876.2–1877.2.

Sub-family Brotulinæ

For a map showing the distribution of the Brotulinæ, see Meek, A. 1916.1 (*p.* 380).

Taxonomy. —*Western North America.* Gill, T. N. 1864.8. —*Review, Japan.* Jordan, D. S. & Starks, E. C. 1902.5. —*Philippines and Dutch East Indies.* Radcliffe, L. 1913.2. —*Abyssal species of northern Atlantic.* Roule, L. 1915.5.

Sub-family Lycodinæ

Taxonomy. —*Synopsis.* Gill, T. N. 1864.20. —*Northern Europe and Greenland.* ★Jensen, A. S. 1904.2.

Lycodes. —*Natural history and taxonomy.* Collett, R. 1899.1; Smitt, F. A. 1900.1. —*Taxonomy and distribution in Arctic ocean.* ★Knipovich, N. M. 1906.3; Lütken, C. F. 1876.1 (iii). —*Variations.* Jensen, A. S. 1901.1.

Family Ophidiidæ

Taxonomy. —*Review, Japan.* Jordan, D. S. & Fowler, H. W. 1902.5. —*Revision.* Putnam, F. W. 1874.4. —*General account.* Kaup, J. J. 1856.3.

Genypterus. *Natural history.* Delfin, F. T. 1903.3.

Family Podatellidæ (Ateleopodidæ)

Taxonomy, Philippines. Radcliffe, L. 1913.1.

Group Blennoidea

Classification. Regan, C. T. 1912.5.

DIVISION TÆNIOSOMI

Taxonomy and relationships. Gill, T. N. 1890.1, Add. 1887.1; Regan, C. T. 1907.11.

Family Trachypteridæ

Caudal rays of Regalecus and Trachypterus. Smitt, F. A. Add. 1888.1.

Regalecus (**Gymnetrus**) (*Oarfish, or "King of the Herrings"*). *Natural history notes, miscellaneous accounts and descriptions.* Ascanius, P. 1788.1; Brünnich, M. T. 1788.1; Couch, J. 1863.1; Drew, S. H. 1898.1; Jones, J. M. 1860.1,.2,.3; Jourdain, S. 1872.1; L'Eost, - 1904.1; Lindroth, P. G. 1798.1; McIntosh, W. C. 1902.3; Risso, A. 1840.1.

Regalecus as the sea serpent. Collett, R. 1884.1; Highley, S. 1877.1; Holder, C. F. 1903.2; Holder, C. F. & Jordan, D. S. 1913.1; Anon. 496.

Occurrence —*in Mediterranean.* Barceló y Combis, F. (*Mallorca*) 1877.1; Buckland, F. T. (*Nice*) 1877.1; Damiani, G. (*Elba I.*) 1913.1; Nardo, G. D. (*Adriatic Sea*) 1824.1. —*Norway.* Collett, R. 1883.2; Grieg, J. A. 1886.1, 1900.1. —*Scotland.* Evans, W. 1908.1; F., A. 1880.1; McIntosh, W. C. 1896.1; Walker, R. 1862.1. —*coast of England.* Hancock, A. & Embleton, D. 1846.1; Harting, J. E. 1880.1; Hogg, J. 1866.1,.2; Jacob, J. 1849.1; Southwell, T. 1880.1,.2,.3; Tristram, H. B. 1866.1; W., J. 1877.2; Whitfield, E. 1849.1. —*in Table Bay, S. Africa.* Layard, E. L. 1868.1, Add. 1869.1.

Distribution in western Atlantic. —*At New Harbor, Maine.* Hanna, S. W. 1883.1. —*In Bermudas.* Jones, J. M. 1860.2,.3; Newman, E. 1860.2; Nilsson, S. 1860.3,.5. —*Off Charleston, S. C.* Rea, P. M. 1909.1.

Distribution in Pacific. —*On California coast.* Jordan, D. S. 1902.8. —*Australia.* De Vis, C. W. (*Queensland*) 1892.1; Ramsay, E. P. (*Port Jackson*) 1881.5; Waite, E. R. (*New South Wales*) 1899.3; Alexander, W. B. Add. 1914.1. —*New Zealand.* Benham, W. B. 1903.1; Clarke, F. E. 1898.1; Forbes, H. O. 1892.1; Haast, J. F. 1878.1; Kingsley, R. I. 1889.1; Parker, T. J. 1884.2, 1887.2, Add. 1883.1.

Taxonomy. —*Mediterranean species.* Damiani, G. 1913.1. —*British species.* Gray, J. E. 1850.2. —*G. banksii.* ★Lütken, C. F. 1876.1 (iv), 1877.2, 1882.1.

Trachypterus (*Dealfish or Northern Ribbonfish*). *Natural history, general accounts, descriptions, etc.* Bonaparte, L. C. 1842.6; Costa, A. 1862.2; Duguid, - 1851.1; Fleming, J. 1831.1; Kner, R. 1859.1; ★Reinhardt, J. C. 1838.2. —*Earliest description.* Goüan, A. 1770.1.

Occurrence —*at Amboina.* Bleeker, P. 1868.8. —*in England.* Bolam, G. 1891.1; Cole, F. J. 1913.1; Anon. 152. —*on coast of Scotland.* Cursiter, J. W. 1896.1; Edwards, T. 1879.1; Evans, W. 1909.1; Lemmon, J. 1905.1; Reid, J. (*Firth of Forth*) 1849.1; Traquair, R. H. (*Shetland*)

1896.1. —*at Venice.* Grisellini, F. 1766.1, 1768.1,.2. —*in California.* Jordan, D. S. & Gilbert, C. H. 1894.1; Snyder, J. O. 1908.3. —*at Madeira Is.* Lowe, R. T. 1852.1. —*in Gulf of Marseilles.* Vayssière, A. 1908.1,.2. —*in Ireland.* Anon. 583; Newman, E. Add. 1875.3.

Taxonomy and relationships. —*Mediterranean Sea.* Bonelli, F. A. 1819.1. —*New Zealand forms.* Clarke, F. E. 1881.1. —*Arctic forms.* ★Lütken, C. F. 1876.1 (iv), 1877.2, 1882.1. —*Species in New South Wales.* Ogilby, J. D. 1898.5. —*Chilian forms.* Philippi, R. A. 1874.1. —*Bergen Museum specimens.* Stuwitz, P. 1840.1.

Family Lophotidæ

Lophotes. *Occurrence —at Cape of Good Hope.* Boulenger, G. A. 1900.13, 1902.26; Günther, A. C. 1890.2; Trimen, R. 1891.1. —*on New Zealand coast.* Clarke, F. E. 1897.1; Parker, T. J. 1894.1. —*in Gulf of Genoa.* Cuvier, G. L. 1813.1. —*Tasmania.* Johnston, R. M. Add. 1883.1.

SUB-ORDER ATELAXIA

Characters of this new sub-order. Starks, E. C. 1908.1.

Family Stylephoridæ

Stylephorus (**Stylophorus**). *Notes, descriptions, etc.* Blainville, H. M. 1818.1; Mitchill, S. L. 1832.1. —*Original description.* Shaw, G. 1791.1.

Taxonomy and relationships based on osteological characters. Regan, C. T. 1908.24; Starks, E. C. 1908.1.

SUB-ORDER OPISTHOMI

Family Mastacembelidæ

For a map showing the geographical distribution of the Mastacembelidæ, see Meek, A. 1916.1 (*p.* 314).

Taxonomy; revision, African species. Boulenger, G. A. Add. 1909.1.

Mastacembelus. *Taxonomy.* —*Indo-Australian Archip.* Bleeker, P. 1866.9. —*Synopsis.* Boulenger, G. A. 1912.10.

SUB-ORDER PEDICULATI

Natural history. ★Gill, T. N. 1909.1.

Taxonomy. Annandale, N. & Jenkins, J. T. (*India*) 1910.1; Gill, T. N. 1864.7, 1880.2, 1883.12; Jordan, D. S. & Sindo, M. (*Japan*) 1902.2; Supino, F. 1908.3.

Family Lophiidæ

Taxonomy, revision. Regan, C. T. 1903.11.

Lophius (*Angler, or Fishing-frog*). *Natural history, occurrence, etc.* ★Fulton, T. W. 1903.1; Geare, R. I. 1903.1; ★Gill, T. N. 1905.4; Honeyman, D. 1886.2; Jones, A. H. 1878.1; Kent, W. S. 1874.1; Montin, L. 1779.1; Turner, W. 1902.1; Anon. 377; Hanow, M. C. Add. 1768.1; Parsons, J. Pre-Linn. 1750.1.

Angling apparatus of Lophius. —*Fishing lure, development, morphology, and function.* Bailly, E. M. 1824.1; Fritsch, G. T. 1884.2; Geoffroy-Saint-Hilaire, E. F. 1824.7,.8,.11, 1827.1; Jourdain, S. 1861.2; Ryder, J. A. 1885.3; Wyman, J. 1848.1. —*Branchial sacs as an angling apparatus.* Geoffroy-Saint-Hilaire, E. F. 1807.6, 1827.1.

Family Ceratiidæ

Taxonomy, synopsis. Gill, T. N. 1879.2.

Ceratias. *Natural history, description and taxonomy.* Kroyer, H. N. 1845.7. —*Arctic regions.* ★Lütken, C. F. 1880.1,.4.

Himantolophus. *Natural history, descriptions and occurrence.* ★Lütken, C. F. 1880.1,.4, 1887.2, 1894.1, Add. 1886.1; Girard, A. A. 1893.2; Williamson, H. C. 1911.2.

Melanocetus. *Descriptions.* Günther, A. C. 1864.8; Regan, C. T. 1913.4.

Oneirodes. *Description.* Lütken, C. F. 1871.2.

Family Antennariidæ

For alleged Nest-building, see Parental care *under* Reproduction.

Taxonomy, synopsis. Gill, T. N. 1879.1.

Antennarius (**Chironectes**). *Natural history, structure and relationships.* Cuvier, G. L. 1817.2; Dönitz, F. K. W. 1867.1; Steenstrup, J. J. 1864.1. —*Variability.* Pietschmann, V. 1909.2.

Pterophryne (*Mousefish or Sargassum-fish*). —*Natural history, nomenclature, etc.* Braam Houckgeest, A. 1774.1; Hjortberg, G. F. 1768.1, Add. 1771.1; Martini, F. H. Add. 1773.1,.3; Seba, A. Pre-Linn. 1734.1. —*Nomenclature.* Gill, T. N. 1879.5. —*Alleged capture in Onondaga lake, New York.* Smith, H. M. 1903.2.

Family Malthidæ

Taxonomy, synopsis. Gill, T. N. 1879.3.

Malthe (*Batfish*). *Natural history notes.* Hutchinson, J. 1797.1; Lütken, C. F. 1865.1; Nicolson, - Add. 1776.1; Seba, A. Pre-Linn. 1734.1.

SUB-ORDER PLECTOGNATHI

Taxonomy. Dareste, C. 1850.2; ★Hollard, H. L. 1860.1; Nardo, G. D. 1842.1, 1843.2; Regan, C. T. 1902.1. —*Indian forms.* Annandale, N. & Jenkins, J. T. 1910.1. —*Specimens in Museum, University of Rome.* Carruccio, A. 1912.1. —*Synopsis.* Gill, T. N. 1885.6.

DIVISION SCLERODERMI

Taxonomy. —*Fossil forms.* Gill, T. N. 1888.3,.5. —*Review, Japan.* ★Jordan, D. S. & Fowler, H. W. 1902.7. —*General account.* Kaup, J. J. 1855.3.

Family Triacanthidæ

Triacanthus. *Taxonomy, revision.* Regan, C. T. 1903.12.

Family Balistidæ

(Filefishes or Triggerfishes)

General treatise (bony structure, classification, etc.). ★Hollard, H. L. 1853.1.

Taxonomy and relationships. — *Indo-Australian Archip.* Bleeker, P. 1852.1, 1866.13, .14. — *Affinities.* Dareste, C. 1872.2,.3. — *Eocene of Monte Bolca.* Zigno, A. 1887.1.

Balistes (*Leather-Jacket*). *Natural history, descriptions, occurrence, etc.* Carte, A. 1854.1; ★Möbius, K. A. 1889.1; Nardo, G. D. 1827.3; Sonnerat, P. 1774.1; Garman, S. Add. 1891.2. — *On English coast.* Gray, J. E. 1873.1; Toms, H. S. 1901.1. — *In Scandinavia.* Malm, A. W. 1875.1. — *At Cork Co., Ireland.* Scharff, R. F. 1910.2. — *Dutch East Indies.* Schlosser, J. A. 1869.1. — *In Massachusetts waters.* Storer, D. H. 1848.14.

Taxonomy; Dutch East Indies. Bleeker, P. 1862.1.

Palæobalistes. *Structure and taxonomy.* Kner, R. 1867.2.

Family Ostraciontidæ

(Trunkfishes)

General treatise (*bony structure, classification, etc.*). ★Hollard, H. L. 1857.2. — *Comment on Hollard.* Duméril, A. M. 1857.1.

Taxonomy. — *Dutch East Indies.* Bleeker, P. 1852.1, 1862.1, 1866.13,.14. — *American species.* Goode, G. B. 1879.15.

Aracana. *Taxonomy, revision.* Waite, E. W. & McCulloch, A. R. 1915.2.

Ostracion (*Trunkfish*). *Natural history and occurrence.* Couch, J. (*English coast*) 1864.1; La Blanchère, P. R. 1874.2.

DIVISION GYMNODONTES

General treatise (*bony structure as a basis for classification*). ★Hollard, H. L. 1857.1.

Taxonomy. Bleeker, P. 1862.1, 1866.13, .14. — *Review, Japan.* Jordan, D. S. & Snyder, J. O. 1901.10.

Family Tetrodontidæ

Puffers or Globefishes

Taxonomy. Duméril, A. H. 1854.1; Gill, T. N. 1892.1. — *Review, American species.* Jordan, D. S. & Edwards, C. L. 1887.1. — *Revision, African species.* Boulenger, G. A. Add. 1909.1. — *Italian fossil forms.* Portis, A. Add. 1889.1.

Evolution; progenitors. Thilo, O. 1914.1.

Tetrodon (**Tetraodon**). *Natural history.* Bugnion, E. 1911.1; Domsma, M. Add. 1770.1; Walbaum, J. J. Add. 1779.1.

For nature of its poisonous flesh, see under Poisonous fishes.

Family Diodontidæ

Taxonomy. Brisout de Barneville, C. 1846.2; Cuvier, G. L. 1818.1; Duméril, A. H. 1854.1. — *Review, American species.* Eigenmann, C. H. 1885.1.

Diodon (*Porcupinefish*). *Fossil forms* — *in Miocene.* Cope, E. D. (*North Carolina*) 1872.8; Pantanelli, D. (*Italy*) 1897.1; Pasquale, M. (*Sardinia*) 1905.1. — *in Eocene.* Lydekker, R. (*Burma*) Add. 1880.1; Portis, A. (*Italy*) Add. 1889.1.

Family Molidæ

Ocean Sunfishes

General treatise; natural history, distribution, structure and taxonomy (*with a full bibliography*). ★Steenstrup, J. J. & Lütken, C. F. **1898.1.**

Taxonomy. Nardo, G. D. 1839.1; ★Ranzani, C. 1839.1; Gill, T. N. Add. 1897.1.

Orthagoriscus (**Mola**). *Natural history notes, popular accounts, and descriptions.* Agassiz, J. L. 1856.5; Acloque, A. 1897.3; Albert I, H. C. 1889.1; Bonaparte, C. L. 1840.3; Embleton, D. 1854.1; Gachet, H. 1832.1; Grieg, J. A. 1903.1; Holder, C. F. 1904.2; Jacob, A. 1826.1; Lidth de Jeude, T. 1892.1; Lindes, L. 1880.13; Lönnberg, A. J. 1909.1; McIntosh, W. C. 1908.2; Maitland, R. T. 1859.1; Marsillon, C. 1897.1; Porter, C. E. 1904.3; Retzius, A. J. 1785.1; Stossich, M. 1880.1; Gadeau de Kerville, H. Add. 1894.1.

Distribution. — *English coast.* Bell, A. S. 1870.1,.2; Clarke, W. J. 1896.1, 1898.1; Cornish, T. 1866.5, 1879.3; Couch, J. 1841.1; Crooks, St. J. 1860.1; Gatcombe, J. 1878.2; Gurney, J. H. 1875.2; Parlby, - 1849.1. — *In Irish waters.* Andrews, W. 1871.1; Bellingham, O. 1840.1. — *Off Scottish coast.* Campbell, J. M. 1881.1; Clark-Kennedy, A. 1875.2; Saxby, H. L. (*Shetland*) 1866.1; Anon. 330.

Occurrence in various localities. — *In East Indies.* Bleeker, P. 1873.10. — *In Italy.* Carruccio, A. 1912.1. — *In Halifax harbor.* Gilpin, J. B. 1874.1. — *Off Portugal.* Girard, A. A. 1894.1. — *At New Zealand.* Hamilton, A. 1886.1. — *Off Mauritius.* Liénard, E. 1840.1. — *In Scandinavia.* Lütken, C. F. 1864.1; Steenstrup, J. J. & Lütken, C. F. 1862.1. — *In Atlantic.* Morthimer, J. H. 1866.1. — *Adriatic Sea.* Nardo, G. D. 1827.2. — *On Dutch coast.* Reuvens, C. L. 1897.2. — *At Boston, Mass.* Storer, D. H. 1844.10. — *New Zealand.* Williams, W. L. 1893.1. — *At Brest, France.* Anon. 155. — *In Rio Pontevedra, Spain.* Colomina, A. Add. 1910.1. — *On California coast.* Hilton, W. A. Add. 1914.1. — *In Nova Scotia.* Piers, H. Add. 1898.1.

Malacanthus (*Larval form of Orthagoriscus*). Guichenot, A. 1848.3.

Ranzania. *Natural history, occurrence, descriptions, etc.* Katuric, M. 1891.1; Stossich, M. 1880.1. — *Hawaiian islands.* Jenkins, O. P. 1895.1. — *Catania, Sicily.* Mauro, S. D. 1905.1. — *Ceylon.* Pearson, J. 1911.2. — *California coast.* Snyder, J. O. 1913.1. — *Martinique.* Pellegrin, J. 1912.14. — *Irish coast.* Scharff, R. F. 1906.2.

SEDIS INCERTÆ

Fossil "fishes" whose affinities with recent fishes are either unknown or are so uncertain that they are set apart here.

General treatise. Woodward, A. S. 1889.2.

I PALÆOSPONDYLIDÆ

Palæospondylus gunni. *Structure and relationships.* — *General accounts.* ★Dean, B. 1896.2, 1896.6, 1898.3, **1900.1,** 1904.12; ★Sollas, W. J. & I. B. 1904.1; Traquair, R. H. 1890.7, 1893.1, 1894.7,.8, 1897.2,.4. — *Shorter papers.* Eastman, C. R. 1900.7; Gill, T. N. 1896.8; Kemna, A. 1904.2; Kerr, J. G. 1900.3; Osborn, H. F. 1900.1.

II OSTRACODERMI

Silurian and Devonian Fishes

Structure and affinities. ★Agassiz, J. L. 1842.2, 1843.1, **1844.3,** 1846.3; Asmuss, H. 1839.1, 1856.1; ★Claypole, E. W. 1884.3,.4,.5, 1891.1; Cope, E. D. 1877.4, 1881.2; ★Kemna, A. 1903.2; Miller, H. 1841.1, 1848.1,.2, 1849.1, 1857.1; ★Pander, C. H. 1856.1, 1857.1; Patten, W. 1902.1, 1903.3; Schlüter, C. A. J. 1888.1; ★Traquair, R. H. 1899.3; Woodward, A. S. 1889.2. — *Depressiform adaptations.* Dollo, L. 1909.4. — *Popular account.* Dawson, J. W. Add. 1893.1.

ORDER HETEROSTRACI

Morphology and affinities. Kemna, A. 1903.2.

Family Cœlepidæ

Structure, affinities and taxonomy. ★Kemna, A. 1904.2; Pander, C. H. 1856.1; Traquair, R. H. 1899.3, 1905.2.

Thelodus. *Morphology and classification.* Röse, C. 1897.1; Traquair, R. H. 1899.2.

Family Drepanaspidæ

Drepanaspis gemündenensis. *Structure and relationships.* Kemna, A. 1904.2; ★Traquair, R. H. 1899.3, 1900.4, 1902.1, 1903.2, 1905.3. — *Scales, marginal and ridge.* Eastman, C. R. 1904.7.

Family Psammosteidæ

Morphology and systematic position. Preobrajensky, J. A. 1911.1; ★Rohon, J. V. (*Anatomy*) 1901.1; Traquair, R. H. 1896.4, 1899.3; Woodward, A. S. 1911.3.

Family Pteraspidæ

Morphology, taxonomy and relationships. Alth, A. 1884.1, 1886.1,.2; Claypole, E. W. 1885.1; Jaekel, O. 1894.2; Kemna, A. 1904.2; Lankester, E. R. 1897.1; Patten, W. 1903.2; ★Rohon, J. V. 1893.1, 1896.1; Schmidt, Fried. 1873.3; Traquair, R. H. 1899.3.

Cyathaspis (Diplaspis). Alth, A. 1886.2; Geinitz, H. B. 1884.1; Lankester, E. R. 1873.2; Lindström, G. 1894.1, 1896.1; Matthew, G. F. 1886.1–1891.1; Roemer, C. F. 1856.1.

Holaspis. *Taxonomy.* Lankester, E. R. 1873.2.

Palæaspis. *Structure and occurrence (in Silurian of Pennsylvania).* Claypole, E. W. 1885.1, 1892.4; Jaekel, O. 1894.2.

Scaphaspis. *Structure (shield and scales) and taxonomy.* Alth, A. 1884.1, 1886.1,.2; Lankester, E. R. 1870.3, 1873.1,.2, 1874.1, 1884.1.

Pteraspis. — *Morphology (cephalic shield and scales) and classification.* Alth, A. 1884.1, 1886.1,.2; Dollo, L. 1903.2; Dorlodot, H. 1912.1,.2; Drevermann, F. 1904.1; Fraipont, C. 1908.1, 1912.1; Gosselet, J. A. 1903.1; ★Huxley, T. H. 1858.1,.2, 1861.2, 1862.1, Add. 1858.1; Katzer, F. (*Brazil*) 1897.1; Kunth, A. 1872.1; ★Lankester, E. R. 1856.1, 1861.1,.2, 1864.2–1866.2, 1873.1,.2, 1874.1; ★Leriche, M. 1903.1,.2, 1912.3, Add. 1912.1; Powrie, J. 1863.1, 1864.2; Schmidt, Fried. 1873.1,.2,.3; Salter, J. W. 1859.1, 1867.2; Woodward, A. S. 1899.6; Huxley, T. H. & Salter, J. W. Add. 1856.1. — *Restoration.* Lankester, E. R. 1862.1; Mitchell, H. 1862.1. — *Distribution in England.* Roberts, G. E. 1861.1.

ORDER OSTEOSTRACI

Structure and affinities. Kemna, A. 1903.2; Kiær, J. 1911.1.

Family Ateleaspidæ

Ateleaspis. *Structure and taxonomy.* Traquair, R. H. 1899.3, 1905.2.

Family Cephalaspidæ

General treatise. ★Powrie, J. & Lankester, E. R. **1868.1.**

Morphology and taxonomy. Kner, R. 1847.1; Lankester, E. R. 1870.2,.4, 1897.1; ★Pander, C. H. 1856.1; Patten, W. 1903.2; Powrie, J. 1861.3, 1870.1; ★Rohon, J. V. 1893.1, 1896.1.

Cephalaspis. *Structure (scales, etc.) and classification.* Eastman, C. R. 1904.7; Huxley, T. H. 1858.2; Niedzwiedzki, J. 1903.1; Salter, J. W. 1869.1; Schmidt, Fried. 1866.1, 1894.1; Traquair, R. H. 1893.6, 1894.5, 1899.1; Woodward, A. S. 1901.2.

Distribution in England. Lightbody, R. 1861.1; Roberts, G. E. 1861.1.

Didymaspis. *Taxonomy.* Lankester, E. R. 1867.2,.3.

Thyestis (Auchenaspis). — *Silurian of Victoria.* Chapman, F. R. 1906.1. — *Morphology and taxonomy.* Rohon, J. V. 1892.2, 1896.1,.2. — *Skull; metamerism.* Rohon, J. V. 1894.1, 1895.2. — *In Silurian of Ösel I.* Schmidt, Fried. 1866.1; Eichwald, C. E. Add. 1854.1.

Family Tremataspidæ

Morphology and affinities. Eastman, C. R. 1902.5, 1904.4; ★Patten, W. 1901.1; ★Rohon, J. V. 1892.2, 1893.2, 1894.2, 1896.1.

Tremataspis. — *Appendages, views concerning.* Eastman, C. R. 1903.2; Jaekel, O. 1903.2; ★Patten, W. 1903.1. — *Skull; metamerism.* Rohon, J. V. 1894.1.

ORDER ANASPIDA

Comprising the family Birkeniidæ and the genera *Birkenia* and *Lasanius*, and doubtfully *Euphanerops*.

Morphology and taxonomy. Kemna, A. 1903.2; Kiær, J. 1911.1; ★Traquair, R. H. 1899.3, 1905.2. —*Euphanerops.* Woodward, A. S. 1900.6.

III ANTIARCHI

Fishes of the Old Red Sandstone

Group established. Traquair, R. H. 1894.2.

Family Asterolepidæ

Monograph. ★Traquair, R. H. 1894.2, 1904.1, 1906.1.

Anatomy and systematic position. ★Jaekel, O. 1903.4; Lankester, E. R. 1897.1; Pander, C. H. 1887.1; ★Traquair, R. H. 1888.5, 1893.5.

Pectoral appendages, structure. Eastman, C. R. 1904.1; ★Hoffman, G. 1911.1; Jaekel, O. 1893.2.

Asterolepis. —*General popular treatise.* ★Miller, H. **1849.1.**

Structure and affinities. Hoffman, G. 1909.1; ★Kemna, A. 1904.2; Miller, H. 1848.2; Eichwald, C. E. Add. 1840.1. — *Hyoid-plate; structure.* Miller, J. 1869.1.

Holonema. —*Structure.* Claypole, E. W. 1883.1, 1890.2. —*Pectoral limb.* Cope, E. D. 1891.3, 1892.5. —*Ventral plates of carapace.* Williams, H. S. 1891.1, 1893.1.

Bothriolepis. *Structure and affinities.* Eastman, C. R. 1904.9; Lahusen, I. I. 1880.1; ★Patten, W. 1904.1, 1905.1; Roberts, G. E. 1864.1; Trautschold, H. 1881.1; Whiteaves, J. F. 1887.1.

Pterichthys. —*Structure and taxonomy.* Beyrich, H. E. 1877.1; Claypole, E. W. 1890.2; Cope, E. D. 1885.3; Egerton, P. G. 1848.1,.2, 1862.1; Fritsch, A. J. 1881.1; Miller, H. 1848.1, 1857.1; Peach, C. W. 1867.1; ★Rohon, J. V. (*Morphology*) 1891.1; Whiteaves, J. F. 1880.1; Woodward, A. S. 1890.4, 1892.10. — *Restoration.* Longmuir, – 1860.1.

IV ARTHROGNATHI

Relationships of Arthrognathi. Dean, B. 1901.4. — *Reviews of Dean.* Eastman, C. R. 1901.4; Jaekel, O. 1903.1.

"ORDER" ANARTHRODIRA

Asterosteus. Newberry, J. S. 1875.1.

Macropetalichthys. —*Cranial structure.* Cope, E. D. 1891.3. —*Characteristics.* Eastman, C. R. 1897.3. —*Taxonomy.* Hennig, E. 1907.1; Kayser, F. H. 1880.2; Norwood, J. G. & Owen, D. D. 1846.1,.2.

"ORDER" ARTHRODIRA

Fishes of the Devonian and Lower Carboniferous. American forms mainly from Ohio.

General treatise, with extensive bibliography. ★Hussakof, L. **1906.1.**

Morphology, taxonomy, and relationships. ★Claypole, E. W. 1890.1, 1893.6, 1894.2, 1895.3, 1896.1; Cope, E. D. 1877.4, 1891.3, 1892.1; ★Dean, B. 1901.4, 1907.1, 1909.5; Dollo, L. 1906.1, 1907.2; Eastman, C. R. 1896.1,.2; Hussakof, L. 1911.1; Kemna, A. 1904.2; Newberry, J. S. 1885.1. —*Catalogue of Dr. Clark's casts.* Clark, W. 1896.1. — *Pelvic fins.* Dean, B. 1909.5.

Mouth formation and body structure. Jaekel, O. 1907.1.

Affinities. Eastman, C. R. (*to Dipnoans*) 1906.1; Hussakof, L. 1909.2.

Popular accounts. Meyer, M. W. 1907.1; Woodward, H. 1878.1.

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"... Index-learning turns no student pale,
Yet holds the eel of science by the tail."
Dunciad, I, 279.

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